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# AgRISTARS

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## Inventory Technology Development

A Joint Program for  
Agriculture and  
Resources Inventory  
Surveys Through  
Aerospace  
Remote Sensing

December 1982

### TECHNICAL SUMMARY OF ACCOMPLISHMENTS MADE IN PREPARATION FOR THE U.S.S.R. BARLEY EXPLORATORY EXPERIMENT

G. M. Chapman and C. L. Dailey

Lockheed Engineering and Management  
Services Company, Inc.



This draft document consists of technical working material that has not been formally reviewed. It has been prepared in this manner in order to provide timely documentation to personnel supporting the Inventory Technology Development project of the Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing program and to provide others in the technical community with a means of staying informed of project tasks.

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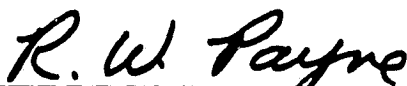
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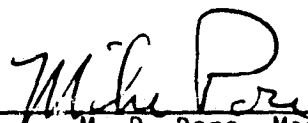
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16. Abstract This document summarizes the highlights of the work accomplished under each subcomponent of the U.S.S.R. Barley Pilot Experiment for 1981, which is now scheduled for completion in 1984. A significant amount of developmental system implementation activity was in the final stages of preparation prior to the rescoping of project tasks. Unpublished materials which are significant to this exploratory experiment are incorporated into the appendixes.					
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## PREFACE

The Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing is a multiyear program of research, development, evaluation, and application of aerospace remote sensing for agricultural resources, which began in fiscal year 1980. This program is a cooperative effort of the U.S. Department of Agriculture, the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration (U.S. Department of Commerce), the Agency for International Development (U.S. Department of State), and the U.S. Department of the Interior.

The work which is the subject of this document was performed by the Earth Resources Applications Division, Space and Life Sciences Directorate, Lyndon B. Johnson Space Center, National Aeronautics and Space Administration and Lockheed Engineering and Management Services Company, Inc., were accomplished under Contract NAS 9-15800.

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## ACRONYMS

AgRISTARS	Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing
APU	Agrophysical unit
ERIM	Environmental Research Institute of Michigan
FCPF	Foreign Commodity Production Forecasting
FSR	Foreign similarity regions
FY	Fiscal year
GDD	Growing degree days
GOAT	Grouped optimal aggregation technique
GT	Ground truth
IR	Indicator regions
LACIE	Large Area Crop Inventory Experiment
LARS	Laboratory for Application of Remote Sensing
MLE	Maximum likelihood estimator
MN	Minnesota, U.S.
MSE	Mean square error
MT	Montana, U.S.
MY	Multiyear
MYGOAT	Multiyear grouped optimal aggregation technique
ND	North Dakota, U.S.
PFC	Production film convertor
RMSE	Root mean square error
SAS	Saskatchewan, Canada
SD	South Dakota, U.S.
SR	Supporting Research

SSG	Spring small grains
TY	Transition Year
USDA	U.S. Department of Agriculture
USGP	U.S. Great Plains
USNGP	U.S. Northern Great Plains

## 1. INTRODUCTION

Because of a March 1981 reduction in the National Aeronautics and Space Administration (NASA) budget for the Foreign Commodity Production Forecasting (FCPF)<sup>1</sup> project of the Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS) program, the fiscal year (FY) 1982 U.S.S.R. Barley Pilot Experiment was cancelled; also as a result, the 1981 exploratory experiment has been replanned for completion in FY 1984. Prior to rescoping FCPF project tasks, a significant amount of developmental system implementation activity was in the final stages of preparation. The U.S.S.R. indicator regions (IR's) and the U.S. foreign similarity regions (FSR's), which support the experiment design function, had been defined and documented. Data and data systems requirements had been formulated, and experiment provisioning was in progress. The preliminary experiment design was near completion. Crop labeling procedures development for the U.S.S.R. barley regions was finished, with only documentation remaining to be completed. Other technology development associated with this foreign exploratory experiment - specifically, the automated barley separation (labeling) technique and the error model - was progressing as scheduled.

This summary outlines the highlights of the work which was accomplished under each experiment subcomponent. Other significant unpublished exploratory experiment materials have been incorporated into the appendixes. The experiment schedules as of April 1, 1981, are shown in figure 1-1.

---

<sup>1</sup>As of January 19, 1982, the project name and objectives were changed. The new name is Inventory Technology Department (ITD).

FOREIGN COMMODITY PRODUCTION FORECASTING (FCPF) PROJECT SCHEDULES  
1981 USSR BARLEY EXPLORATORY EXPERIMENT

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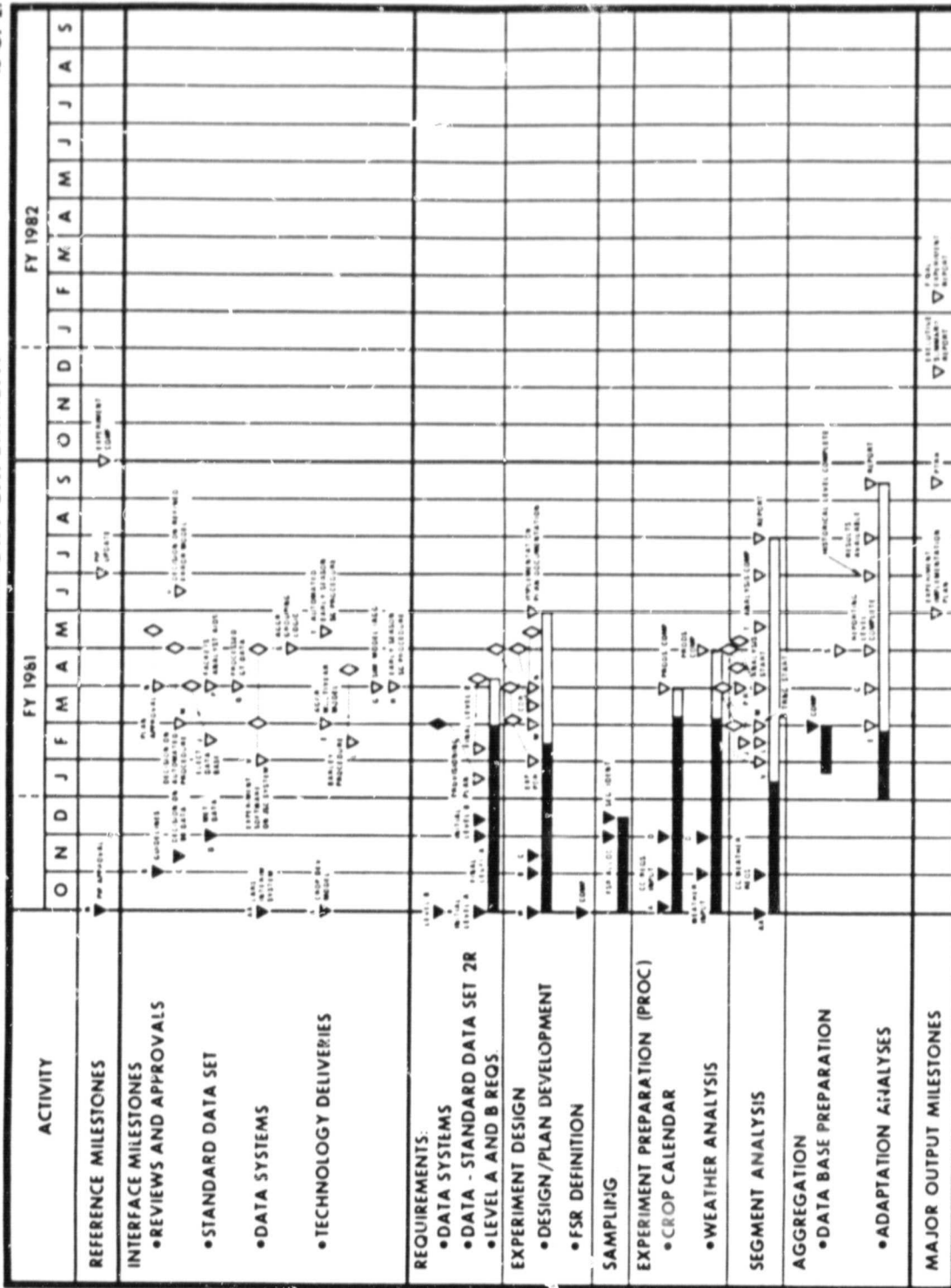


Figure 1-1.- FCPF project schedules for 1981, U.S.S.R. Barley Exploratory Experiment.

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FOREIGN COMMODITY PRODUCTION FORECASTING (FCPF) PROJECT SCHEDULES  
1981 USSR BARLEY EXPLORATORY EXPERIMENT (CONTINUED)

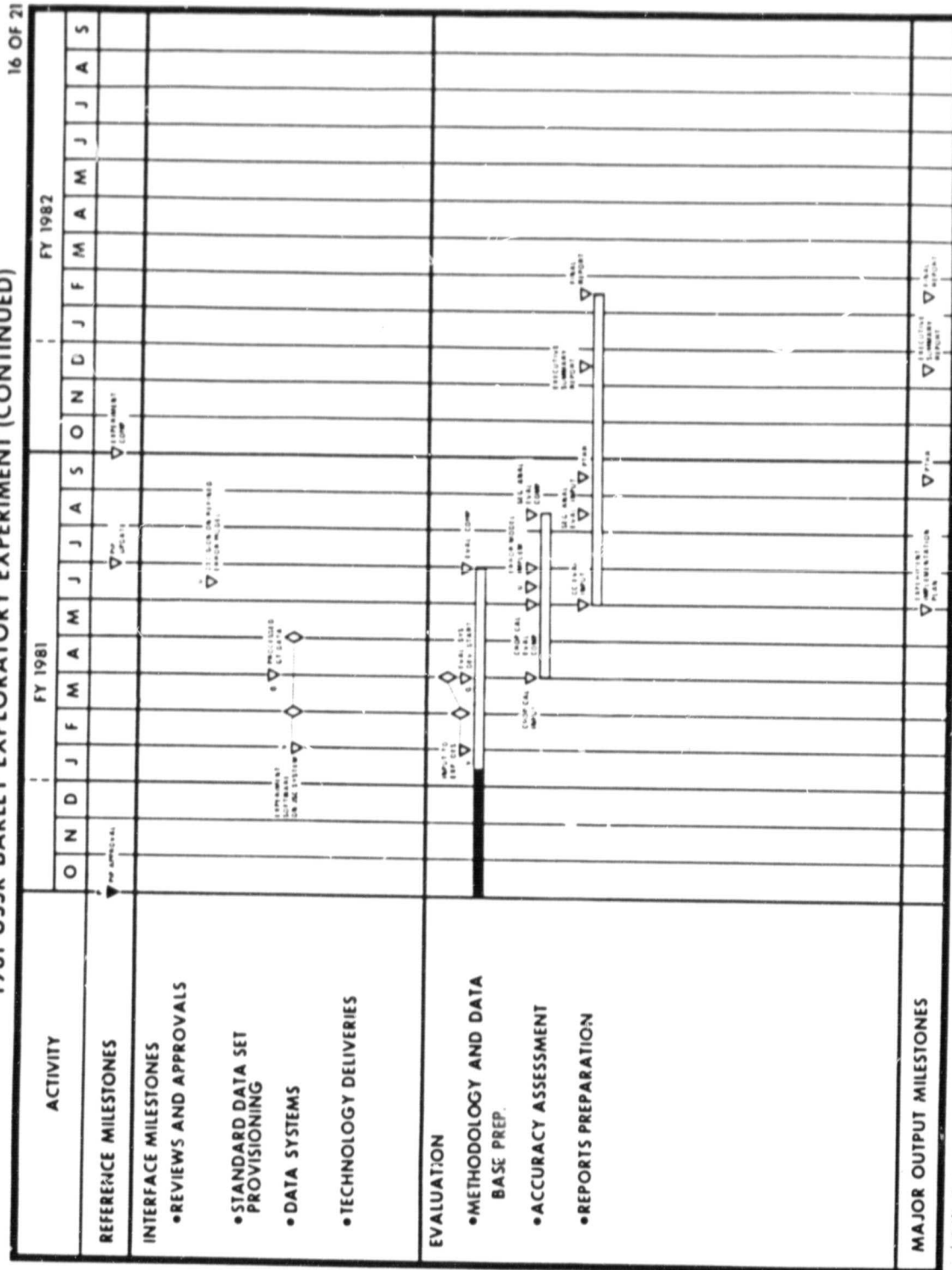


Figure 1-1.- Concluded.

## 2. EXPERIMENT DESIGN

### 2.1 DEFINED IR's (figure 2-1, ref. 1)

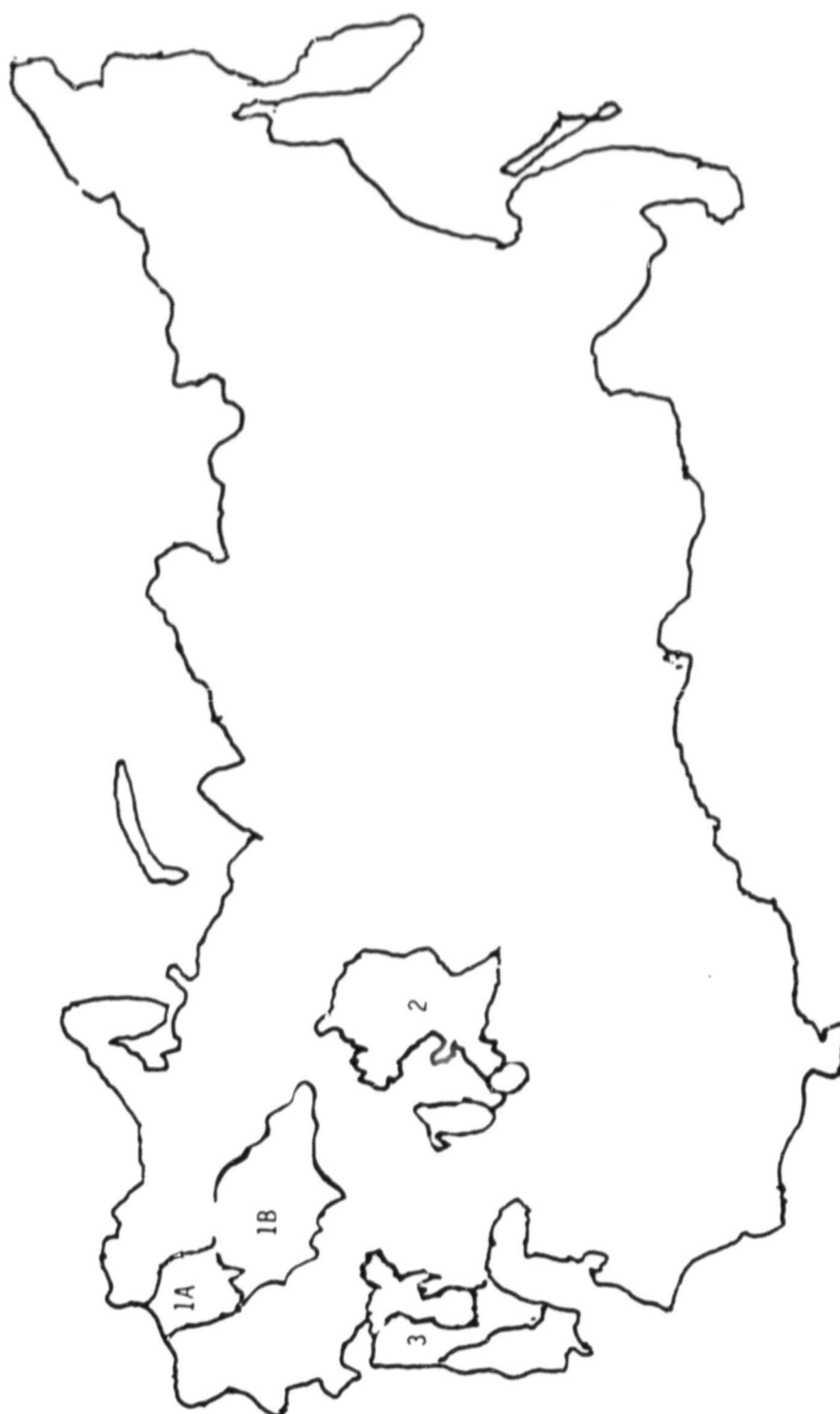
- High barley regions
  - Belorussia
  - Central Region (added after original IR selection)
- Barley/spring wheat region
  - Ural Region
- Barley/winter wheat region
  - North Caucasus Region

### 2.2 DEFINED FSR's (figure 2-2, ref. 2)

- High barley region
  - Agrophysical unit (APU) 104 Montana
- Barley/spring wheat region
  - APU 20 North Dakota and Minnesota
  - Southern Manitoba and Saskatchewan
- Barley/winter wheat regions
  - APU 23 Montana
  - Whitman County, Washington
  - Bannock, Franklin, Oneida, and Pierce Counties, Idaho

### 2.3 PRELIMINARY DESIGN (See appendix A for detailed information.)

- Assessment of available data completed
- Assessment of current technology completed
- Preliminary plans in work
- FCPF Project Management briefing materials in work



Legend:

- |                      |                         |
|----------------------|-------------------------|
| 1 - HIGH BARLEY      | 2 - BARLEY/SPRING WHEAT |
| A. Belorussia Region | Ural Region             |
| B. Central Region    |                         |
|                      | 3 - BARLEY/WINTER WHEAT |
|                      | North Caucasus Region   |

Figure 2-1.- Defined IR's in the U.S.S.R.

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U.S.S.R. SIMILARITY REGIONS

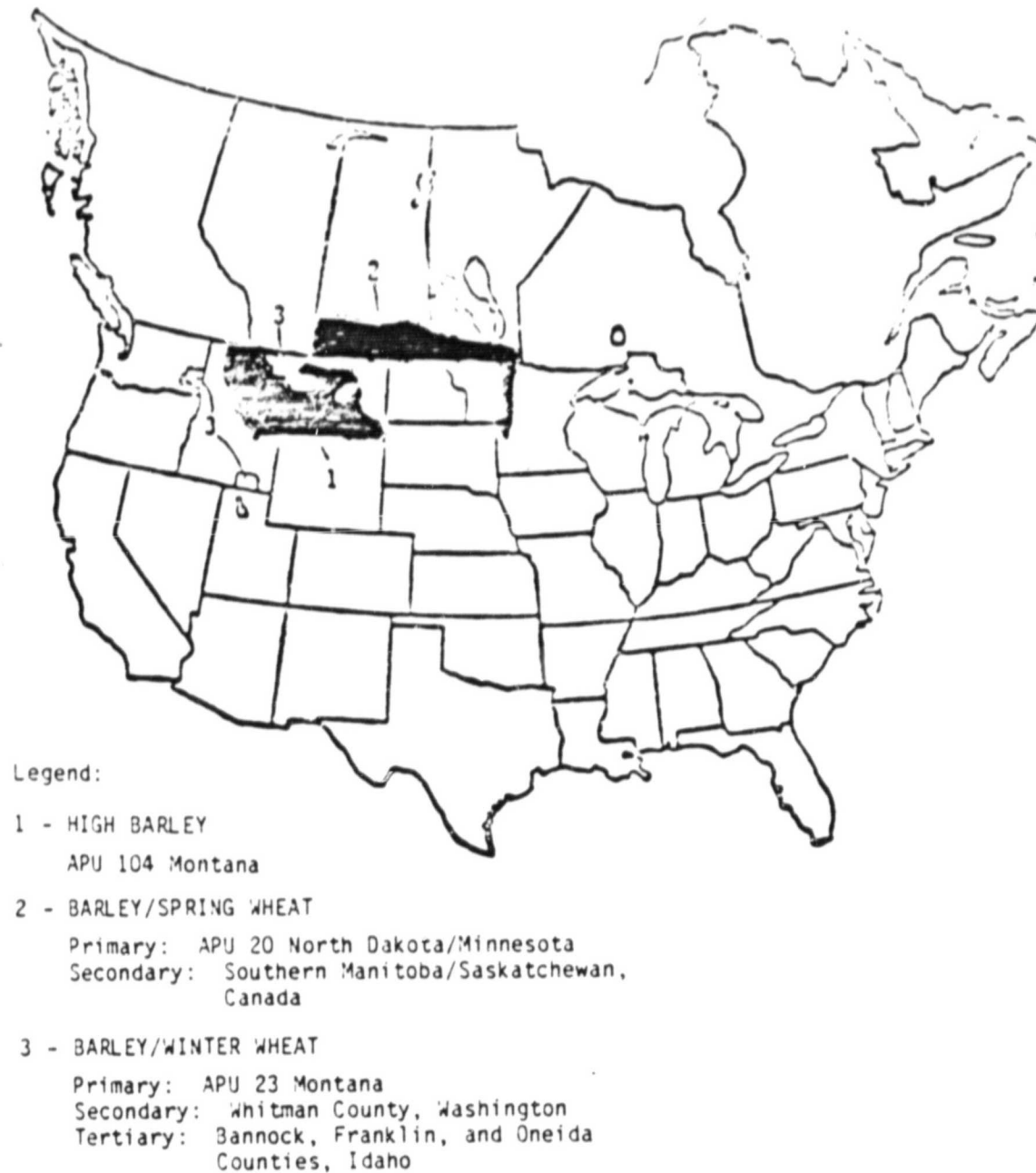


Figure 2-2.- FSR's for the U.S.S.R.

### 3. DATA REQUIREMENTS

- Level A experiment requirements completed (figure 3-1)
- Initial Level B experiment requirements completed. (Detailed requirements are in appendix B.)
- Final Level B experiment requirements are in work.
  - Dropped yield requirements
  - Chose a subset of the originally requested Landsat data (figures 3-2 through 3-6).

# STANDARD DATA SETS

		REQUIREMENT		AUTHORIZED	CATALOGED
D E L E M E N T	Experiment Data Set Title	Crop Tech.		Barley/other small grains	
	Region	USSR 12 & PSP			
	Experiment Period (year noted)	1975-1981			
	S/C Landset 2 3 D	L-4 5 L-7			
S E N S O R	A/C High med low	High			
	Sensor MSS RBV TM	MSS RBV			
	Acc period/freq	MAR-DEC 1975-76			
	Seq	2/season, 1/30-1003W			
D A T A	Number of segments	USSR 15 CANADA 40			
	5 x 5 n m, unless noted	40 50 40			
	Data Type HDT, CCT	HDT/CCT			
	Probs. File Seq. PP	Seq and PP			
C L A S S	Y A At dot labels Area code	USSR 15 CANADA 40			
	CCIT	X X X			
	Class mode Cluster mode	X X X			
	DTRM	X X X			
G R O U N D O B S.	H/C And 1 SPs, TP's	all all all			
	Number of GT segments	all available			
	A/C photo/field overlay	both			
	Site type SS, ITS, TS	all all all			
M E T. D A T A	Inventories:	2/season-near harvest			
	• Acc. freq. 1/season, fall, spring	5 after planting			
	• Coverage (10-W, spec. fields)	W-W			
	Periodic observations:	9 day special fields			
A G R O N O M I C	Hand copy	both			
	GT mean	X X X			
	418-dot D/B	X X X			
	UGTT	X X X			
C R O P C A L D A	Field sketches	X X X			
	Hist. Daily, weekly, monthly	1975-1981			
	Curr. year	1975-1981			
	How eval. Ground	X X X			
Y I E L D D A	Season	X X X			
	Standard	X X X			
	Unique	X X X			
	Met. summary	X X X			
M A P S	APU area map	X X X			
	Geographic description of area	X X X			
	Phenology data - Hist. - Crop	X X X			
	CRD map	X X X			
Y I E L D D A	Hist. Agr. data	X X X			
	Summary	X X X			
	Historic Crop Calendar	X X X			
	Adjustable Crop Calendar (agronom, spectral, hybrid)	X X X			
M A P S	Yield Model estimates	X X X			
	• Political • Topographic • Mosaic	Topo Soils Political Segment Location 1 year			
	• Thematic overlays • Thematic (soils, etc.)				
	TASK NUMBER(S) (SR) 04- USING DATA SET (FCPF)02-	13-04, 13-05			

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\*see addendum sheet.

Figure 3-1.- Standard data sets.

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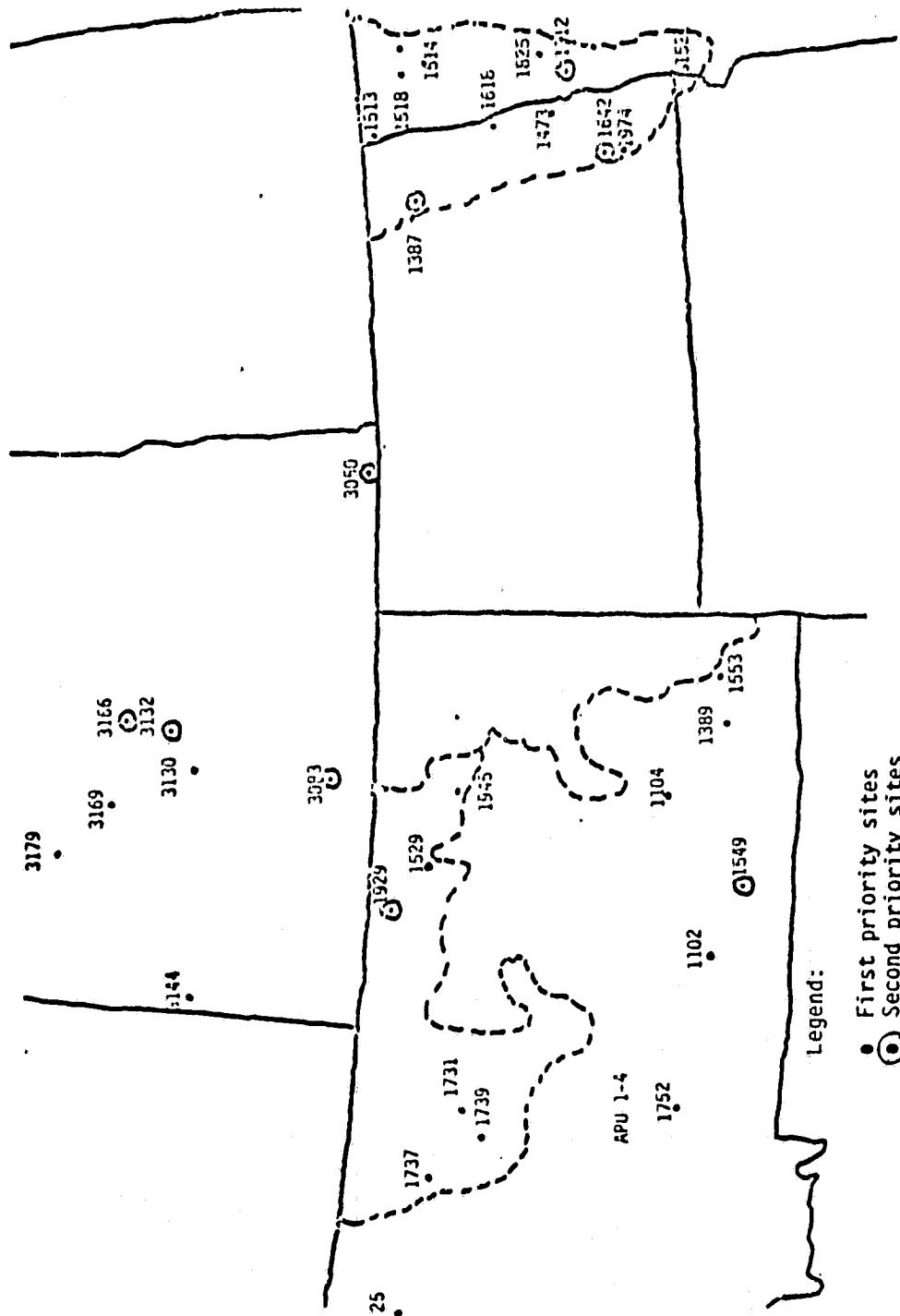


Figure 3-2.- FSR data set, U.S.S.R. Barley Exploration Experiment.

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- 1976
- ★ 1977
- ▲ Alternative (1977)



Figure 3-3.- Barley/spring wheat IR, Ural Region.

The map shows the geographical distribution of plant species across the Rostov and Stavropol Territories. The Rostov Territory is on the left, and the Stavropol Territory is on the right. The legend indicates three types of data points: solid circles for 1976, solid stars for 1977, and solid triangles for an alternative 1977 distribution. Dashed lines outline specific regions within each territory.

Year / Distribution Type	Species Number	Location (Territory)
1976	7382	Rostov
1976	7379	Rostov
1976	7395	Rostov
1976	7882	Rostov
1976	7361	Stavropol
1976	7853	Stavropol
1977	7377	Rostov
1977	7890	Rostov
1977	7343	Stavropol
Alternative (1977)	7389	Rostov
Alternative (1977)	7374	Rostov
Alternative (1977)	7192	Stavropol
Alternative (1977)	7849	Stavropol

- 1976
- ★ 1977
- ▲ Alternative (1977)

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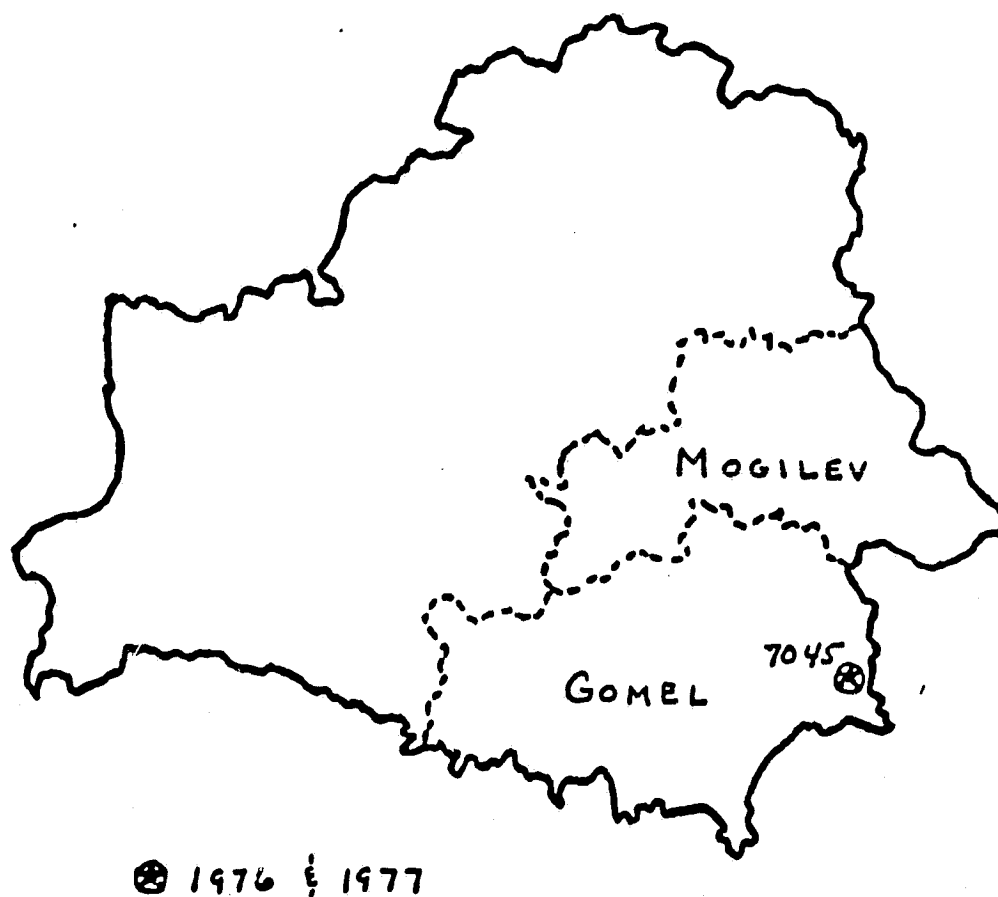
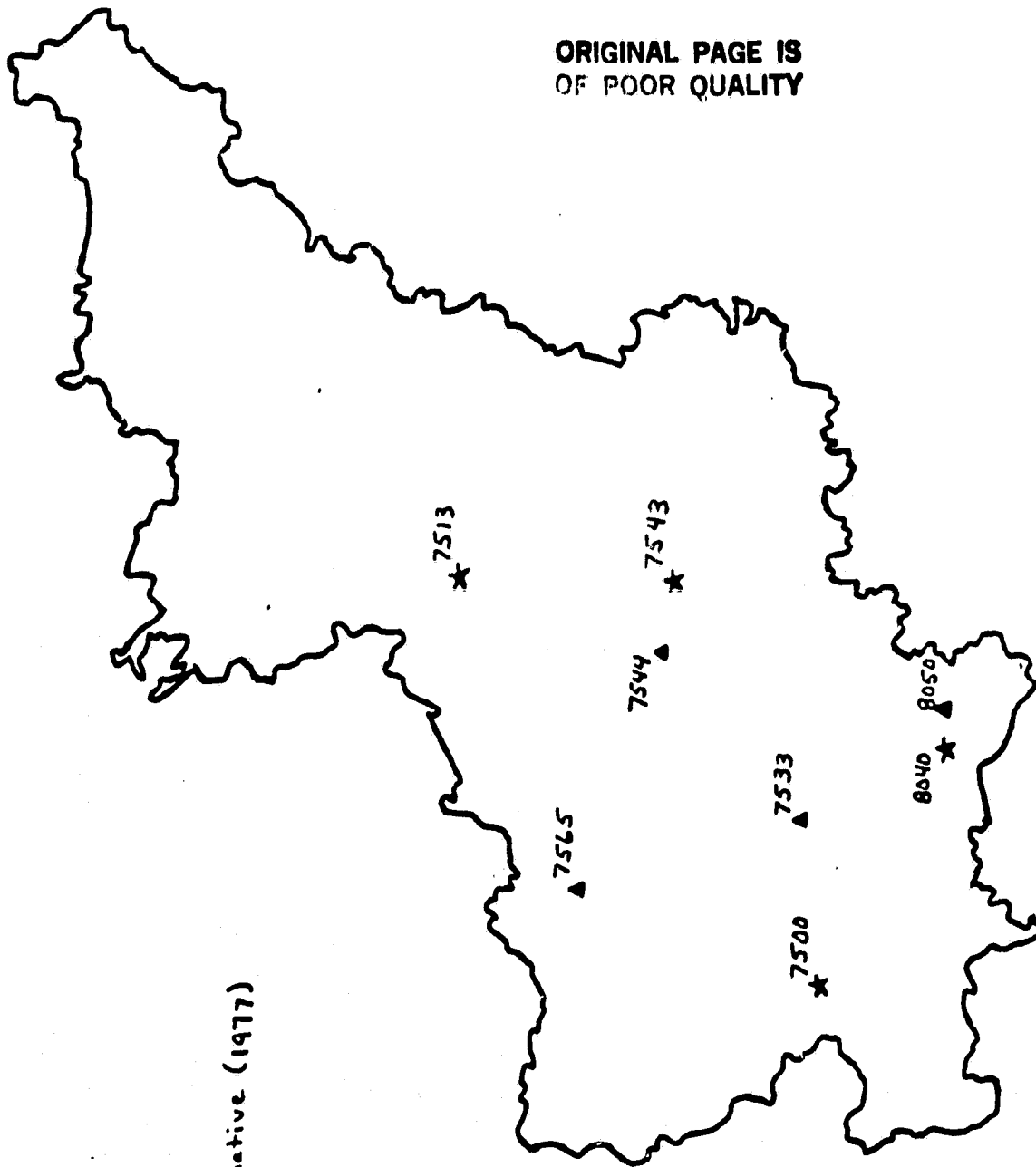


Figure 3-5.- High barley IR, Belorussia, 1976 and 1977.

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○ 1976  
★ 1977  
▲ Alternative (1977)

Figure 3-6.- High barley IR, Central Region.

#### 4. SAMPLING

Reallocation of 1981 Landsat segments for the U.S.S.R. FSR's (see appendix C) was completed; the reallocation was done to emphasize the study of barley (ref. 3).

## 5. EXPERIMENT PREPARATION

- U.S.S.R. meteorological data were procured.
  - Meteorological data from 1969 through 1980
  - First order station collection
  - Contains daily maximum and minimum temperature and amounts of precipitation
  - Contains adequate information to create required crop calendar and weather analysis products
- Meteorological data bases were set up for 1976 and 1977 for the IR's.
- Biowindow midpoint model was run for the 1977 IR segments.
- Generation of the other U.S.S.R. crop calendar and weather analysis products was postponed after the announcement of the budget reduction.
- Crop calendar and weather analysis products for the FSR segments were generated because these segments were also required for the U.S./Canada Spring Small Grains (SSG) Pilot Experiment.

## 6. SEGMENT ANALYSIS

- Labeling development task, consisting of the following study areas, completed:
  - Verification of the baseline SSG procedure for use in the U.S.S.R. and recommendation of necessary changes
  - Modification of existing strategy for separating winter small grains from spring small grains
  - Recommendations on the use of currently available barley separation techniques in the U.S.S.R.
  - Studies and recommendations on the applicability of current crop calendar and biowindow midpoint models to U.S.S.R. data
  - Results and recommendations for documentation of the labeling development task in progress (ref. 4)

## 7. AGGREGATION

The U.S.S.R. historical at-harvest data base was procured and digitized.

## 8. ACCURACY ASSESSMENT

- Initial development of the error model is completed.
- Testing of the model is planned to occur in the U.S. SSG Pilot Experiment.

## 9. ASSOCIATED TECHNOLOGY DEVELOPMENT

- Development of a barley separation procedure is in progress within the ITD project technology development task.
  - The procedure uses the pixels (picture elements) labeled spring small grains in combination with meteorological variables to separate the barley from other spring small grains.
  - Software for this procedure has been completed.
  - Definition of coefficients remains to be completed.
  - Plans are to continue development and testing.

## 10. CONCLUDING REMARKS

- Barley separation results in the U.S.S.R. Exploratory Barley Experiments are anticipated to be similar or worse than those in U.S. Transition Year (TY) experiments.
  - Sampling in both areas optimizes wheat (not barley) identification.
  - Only 18-day acquisition histories available in the IR's.
  - Different crop mix exists.
  - Drought stress was detected in U.S.S.R. SSG/barley IR.

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JSC-16828, January 9, 1981, pp. A6-5.

## **PRELIMINARY EXPERIMENT DESIGN**

### **APPENDIX A**

#### **ASSESSMENT OF FY 1981 U.S.S.R. BARLEY EXPLORATORY EXPERIMENT**

- A.1 PRELIMINARY EXPERIMENT DESIGN**
- A.2 TECHNOLOGY ASSESSMENT**
- A.3 DATA ASSESSMENT**

## PRELIMINARY EXPERIMENT DESIGN

### APPENDIX A

#### ASSESSMENT OF FY 1981 BARLEY EXPLORATORY EXPERIMENT

Appendix A consists of three major divisions. The appropriate division heading is printed at the top of each page in this appendix. All data are categorized within one of these major divisions with subheadings numbered according to standard documentation format.

#### A.1 PRELIMINARY EXPERIMENT DESIGN

##### A.1.1 GENERAL OBJECTIVES

- Evaluation of an at-harvest SSG/barley proportion estimation technology developed in the United States and adapted to a foreign country.
- Definition of a U.S.S.R. barley baseline procedure by evaluating and comparing results of alternative technologies.
- Evaluation of the first method of assessing proportion estimation accuracy in the event that ground observations are unavailable.
- Evaluation in the U.S. of the effects of known U.S.S.R. data restrictions on multiyear aggregation procedures.

##### A.1.2 SPECIFIC OBJECTIVES

- To determine the performance (in terms of labeling accuracy and proportion estimation accuracy) of the adapted SSG2 procedure.
- To determine the effect of automating the barley labeling component of the adapted SSG2 procedure.
- To determine the effect of having a manual pasture filter component as contrasted with having none in the adapted SSG2 procedure.
- To determine the effect of automating the pure-pixel identification module of the adapted SSG2 procedure.
- To determine the effect of automating the acquisition selection of the adapted SSG2 procedure.

## PRELIMINARY EXPERIMENT DESIGN

- To determine the performance (in terms of proportion estimation accuracy) of the following procedure.
  - The SSG4 (spatial/color sequence) procedure with complete enumeration of spring small grains.
  - The SSG4 (spatial/color sequence) procedure with the automated barley labeler and the three-category proportional Bayesian estimation technique.
- To evaluate state-of-the-art accuracy assessment methodology for a foreign area where little or no ground observation information is available.
- To evaluate state-of-the-art adaptations of multiyear aggregation procedures incorporating a multiyear model and an updated grouping logic to a foreign area.
  - The effect of restricted multiyear data on aggregations.
  - The effect of limited historical data on aggregations.
- To evaluate the effect of the biowindow midpoint model.

### A.1.3 SCOPE

- Areas<sup>1</sup> of study (tables A-1 and A-2; figures A-1 through A-7)
  - 25 FSR segments
  - 20 IR segments
- Crop years
  - 1976-80 for multiyear aggregation
  - 1976-79 for FSR evaluations
  - 1977 for IR evaluations

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<sup>1</sup>It is necessary to have both FSR and IR segments to evaluate the spring small grains error model.

# PRELIMINARY EXPERIMENT DESIGN

TABLE A-1.- FSR DATA SET - U.S.S.R. BARLEY EXPLORATORY EXPERIMENT

Segment number	FSR	State or Province	APU	1976	1977	1978	1979
1102	High barley	MT	104	x			
1104	High barley	MT	104		x		
1389	High barley	MT	104		x		
1553	High barley	MT	104		x		
<sup>a</sup> 1725	High barley	MT	104		x	x	
1739	High barley	MT	104	x			
1752	High barley	MT	104		x		
1529	Barley/winter wheat	MT	23		x		
1731	Barley/winter wheat	MT	23			x	
1739	Barley/winter wheat	MT	23	x			
1945	Barley/winter wheat	MT	23			x	
1473	Barley/spring wheat	ND	20				x
<sup>a</sup> 1513	Barley/spring wheat	MN	20	x	x		
1514	Barley/spring wheat	MN	20				x
1518	Barley/spring wheat	MN	20			x	
<sup>a</sup> 1521	Barley/spring wheat	MN	20	x	x		
1523	Barley/spring wheat	MN	20		x		
1618	Barley/spring wheat	ND	20	x			
1825	Barley/spring wheat	MN	20				x
1974	Barley/spring wheat	ND	20			x	
3130	Barley/spring wheat	(SAS)	SAS				x
3144	Barley/spring wheat	(SAS)	SAS				x
<sup>a</sup> 3169	Barley/spring wheat	(SAS)	SAS			x	x
3179	Barley/spring wheat	(SAS)	SAS				x
<sup>a</sup> 3197	Barley/spring wheat	(SAS)	SAS			x	x
Alternates:							
1549	High barley	MT	104	x			
1929	Barley/winter wheat	MT	23		x		
1512	Barley/spring wheat	MN	20	x			x
1642	Barley/spring wheat	ND	20	x			
3050	Barley/spring wheat	(SAS)	SAS			x	
<sup>a</sup> 3083	Barley/spring wheat	(SAS)	SAS			x	x
3132	Barley/spring wheat	(SAS)	SAS			x	
3166	Barley/spring wheat	(SAS)	SAS			x	

<sup>a</sup> indicates segment with more than one year of data.

# PRELIMINARY EXPERIMENT DESIGN

TABLE A-2.- IR DATA SET - U.S.S.R. BARLEY EXPLORATORY EXPERIMENT

Segment number	FSR	Oblast	1976	1977
<sup>a</sup> 7045	High barley	Gomel	x	x
7500	High barley	Bryansk		x
7513	High barley	Vladmir		x
7543	High barley	Moscow		x
8040	High barley	Orel		x
7343	Barley/winter wheat	Stavropol		x
7377	Barley/winter wheat	Rostov		x
7379	Barley/winter wheat	Rostov	x	
7382	Barley/winter wheat	Rostov	x	
7395	Barley/winter wheat	Rostov	x	
7853	Barley/winter wheat	Stavropol		x
7880	Barley/winter wheat	Rostov		x
7955	Barley/spring wheat	Orenburg	x	
7966	Barley/spring wheat	Orenburg		x
7967	Barley/spring wheat	Orenburg	x	
7971	Barley/spring wheat	Orenburg		x
7995	Barley/spring wheat	Orenburg		x
8762	Barley/spring wheat	Orenburg		x
8773	Barley/spring wheat	Orenburg		x
Alternates:				
7533	High barley	Kaluga		x
7544	High barley	Tula		x
7565	High barley	Smolensk		x
8050	High barley	Orel		x
7962	Barley/spring wheat	Orenburg		x
7990	Barley/spring wheat	Orenburg		x
8816	Barley/spring wheat	Orenburg		x
8830	Barley/spring wheat	Orenburg		x
9437	Barley/spring wheat	Orenburg		x
7361	Barley/winter wheat	Stavropol		x
7347	Barley/winter wheat	Rostov		x
7389	Barley/winter wheat	Rostov		x
7792	Barley/winter wheat	Stavropol		x
7849	Barley/winter wheat	Stavropol		x
7882	Barley/winter wheat	Rostov		x

<sup>a</sup>Indicates segment with more than one year of data.

# PRELIMINARY EXPERIMENT DESIGN

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## U.S.S.R. SIMILARITY REGIONS



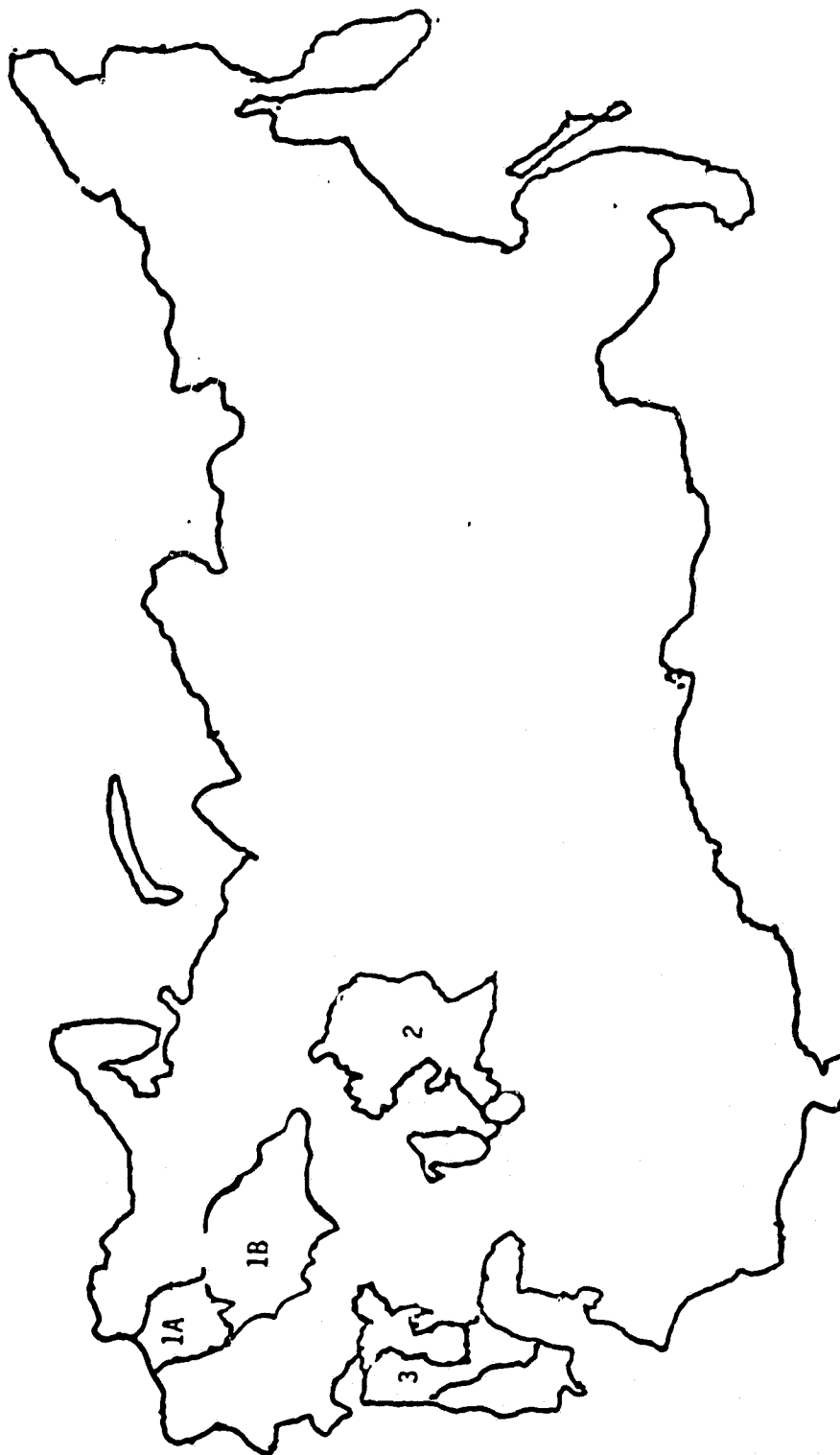
### Legend:

- 1 - HIGH BARLEY  
APU 104 Montana
- 2 - BARLEY/SPRING WHEAT  
Primary: APU 20 North Dakota/Minnesota  
Secondary: Southern Manitoba/Saskatchewan,  
Canada
- 3 - BARLEY/WINTER WHEAT  
Primary: APU 23 Montana  
Secondary: Whitman County, Washington  
Tertiary: Bannock, Franklin, and Oneida  
Counties, Idaho

Figure A-1.- FSR's for the U.S.S.R.



PRELIMINARY EXPERIMENT DESIGN



Legend:

- 1 - HIGH BARLEY
  - A. Belorussia Region
  - B. Central Region
- 2 - BARLEY/SPRING WHEAT  
Ural Region
- 3 - BARLEY/WINTER WHEAT  
North Caucasus Region

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Figure A-3.- Defined IR's in the U.S.S.R.

PRELIMINARY EXPERIMENT DESIGN

- 1976
- ★ 1977
- ▲ Alternative (1977)

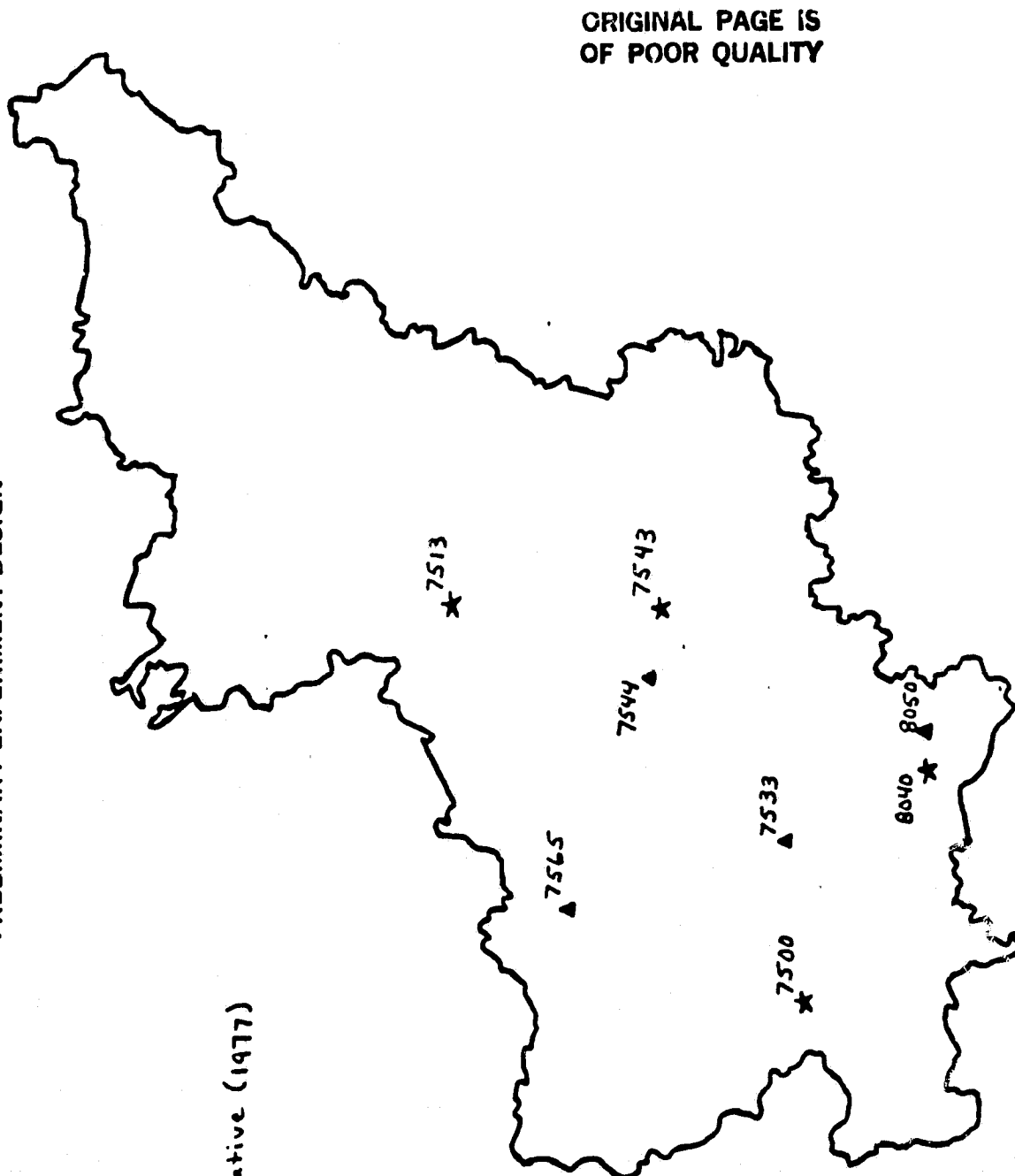


Figure A-4.- High barley IR, Central Region.

PRELIMINARY EXPERIMENT DESIGN

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Figure A-5.- High barley IR, Belorussia.

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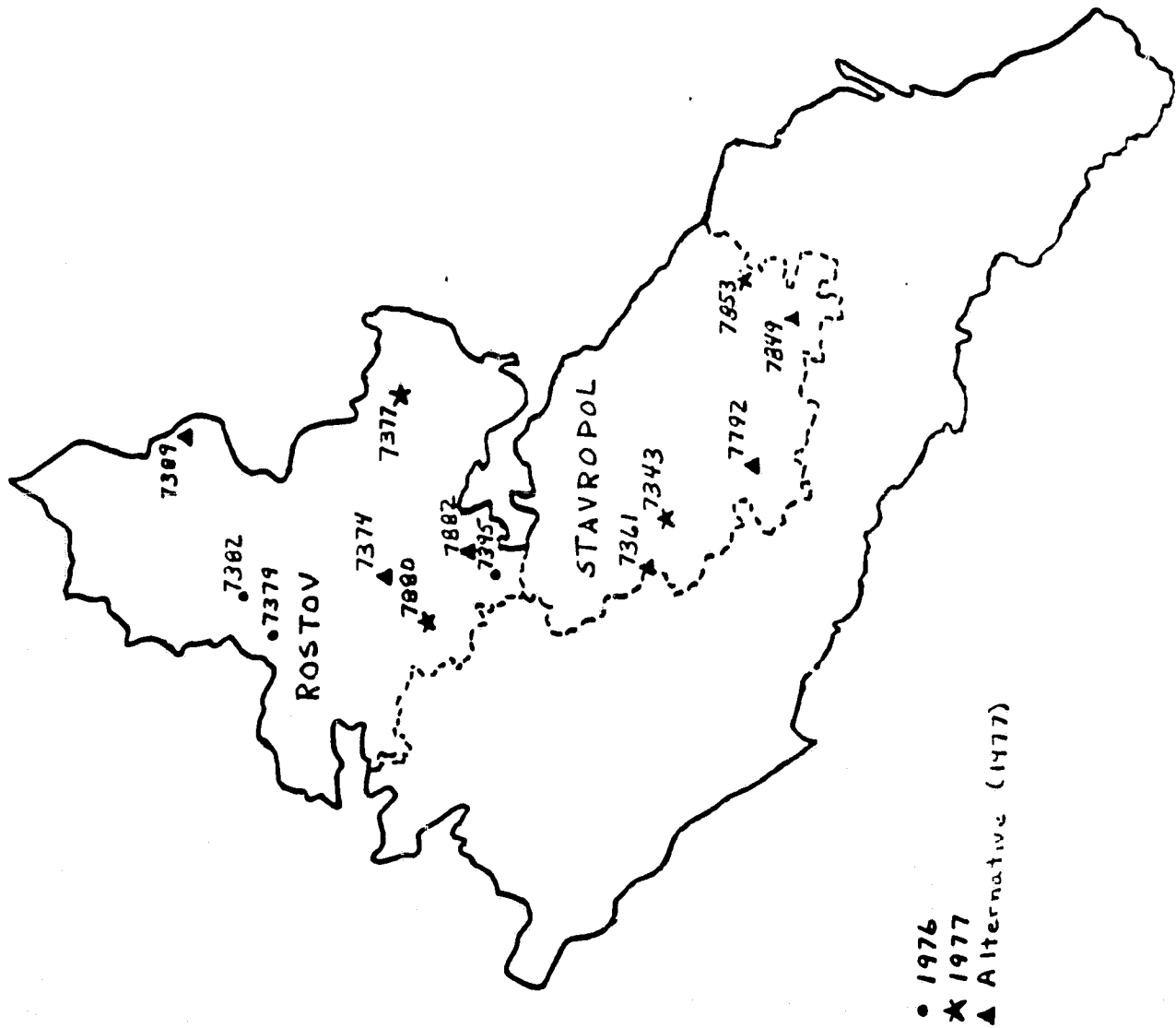


Figure A-6.- Barley/winter wheat IR, North Caucasus Region.

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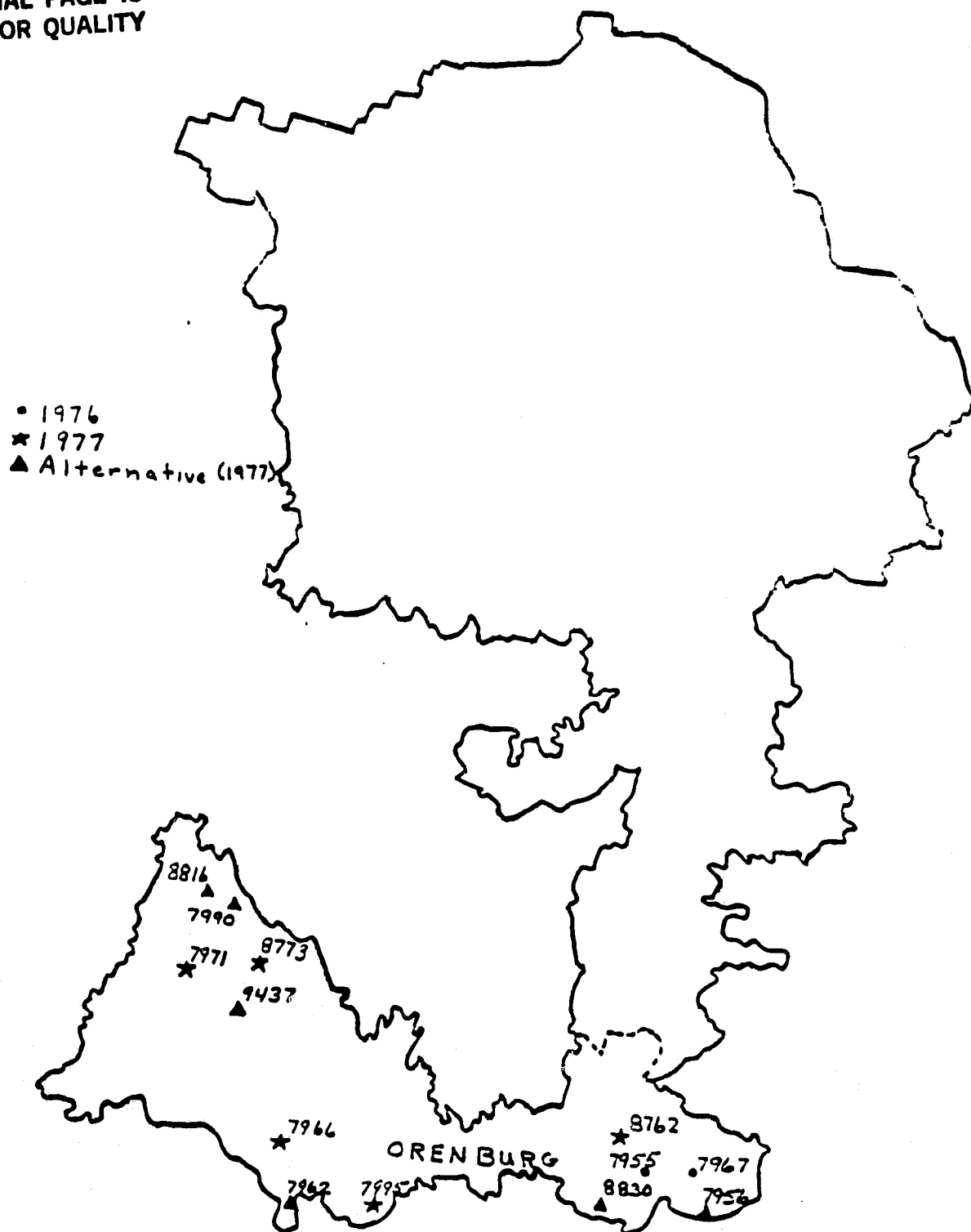


Figure A-7.- Barley/spring wheat IR, Ural Region.

## PRELIMINARY EXPERIMENT DESIGN

### A.1.4 APPROACH

- Proportion estimates will be generated for segments in the FSR's for the adapted SSG2 procedure and four modifications to it.
  - The modifications are either the automation or exclusion of a manual subcomponent
    - First, an automated barley labeling subcomponent will be substituted for the manual barley procedure.
    - Second, (in addition to the automated barley labeler) no pasture filtering task will be performed by analysts; the pasture filter is a labeling step performed by analysts to reduce commission errors.
    - Third, (in addition to the automated barley labeler and no use of the pasture filtering task) an automated pure-pixel selection subcomponent will be substituted for the task performed by analysts.

Pure pixels are used in labeling. When a boundary pixel is encountered, an alternate pure dot is associated with it and used for labeling.
    - Fourth, an automated acquisition selection procedure will be used (in addition to the automated barley labeler, no use of the pasture filtering task, and an automated pure-pixel selection subcomponent).
      - ~ The semiautomated acquisition selection procedure requires analysts to check the automatically selected acquisitions for appropriateness.
  - These modifications were selected to determine the effects of the automated versions of the subcomponents at a minimal expense. There are 32 possible combinations. Proportion estimates cannot be generated for all configurations. Only five were used. By this design, intermediate analyst results from the SSG2 procedure can be used for input into automated subcomponents so additional analyst input will not be required.

## PRELIMINARY EXPERIMENT DESIGN

- Proportion estimates will be generated for segments in the IR's for the adapted SSG2 procedure.
- Proportion estimates will be generated for segments in the FSR's and IR's for the spatial/color sequence (SSG4) procedure.
  - SSG dots used in the baseline will be given SSG4 labels and then be put through the automated barley labeler.
- Proportion estimates will be generated using ground-truth (GT) labels (barley, other spring small grains, or nonsmall spring grains).
- Error model will be applied to segments.
- North Dakota segments will be aggregated for area estimation based on GT labels and limited historical data and restricted multiyear data.

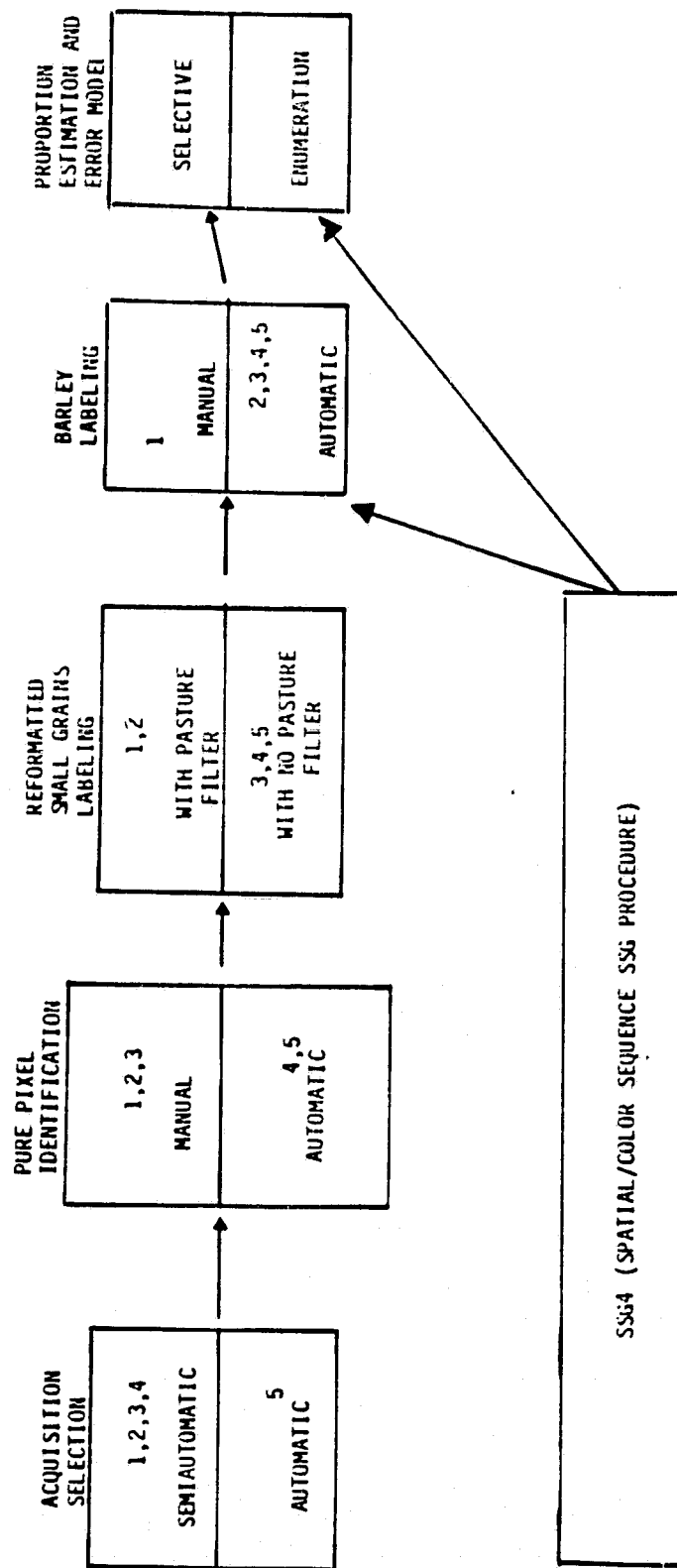
### A.1.5 METHODOLOGY

- Process 25 FSR and 20 IR segments with the adapted SSG2 procedure.
  - Configuration 1 (fig. A-8)

Process segments using: semiautomatic acquisition selection, manual pure-pixel selection, analyst pasture filter (manual subcomponent), adapted reformatted SSG labeling, manual barley labeling, and three-category proportional Bayesian estimation technique.
- Process 25 FSR segments with baseline procedure modified by automated components.
  - Configuration 2 (fig. A-8)

Process segments using: semiautomatic acquisition selection, manual pure-pixel selection, analyst pasture filter (manual subcomponent), adapted reformatted SSG labeling, automated barley labeling, and three-category proportional Bayesian estimation technique. This is done to determine the effect of the automated barley labeler; it requires no additional analyst contact time.

# PRELIMINARY EXPERIMENT DESIGN



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Figure A-8.- System options (configurations keyed by number).

## PRELIMINARY EXPERIMENT DESIGN

### - Configuration 3 (fig. A-8)

Process segments using: semiautomatic acquisition selection, manual pure-pixel selection, no pasture filter, adapted reformatted SSG labeling, automated barley labeling, and three-category proportional Bayesian estimation technique. This is done to determine the additional effect of having no pasture filter; it requires no additional analyst contact time.

Assumption: The pasture filter will perform as well with manual pure dots as with automated pure dots.

### - Configuration 5 (fig. A-8)

Process segments using: automated acquisition selection, automated pure-pixel identification, no pasture filter, adapted reformatted SSG labeling, automated barley labeling, and three-category proportional Bayesian estimation technique. This is done to determine the additional effect of the automated acquisition selection component; it requires no additional analyst contact time.

- Process 25 FSR and 20 IR segments with the SSG4 (spatial/color sequence) procedure.
  - With complete enumeration for SSG
  - With dots put through the barley labeler and three-category proportional Bayesian estimation technique.
- Process 25 FSR segments using GT labels (barley, other spring small grains, and non-small grains) and the three-category proportional Bayesian estimation technique.
- Process 25 FSR and 20 IR segments using the integrated procedure.
- Apply the error model to the FSR segments and to the IR segments.

## PRELIMINARY EXPERIMENT DESIGN

- In North Dakota, aggregate area estimates of 1976-80
  - Produce aggregations using GT labels and varying quantities of historical data.
  - Produce aggregations using GT labels and varying quantities of available past years' data.

Use 1976, 77, 78 data in multiyear grouped optimal aggregation technique (MYGOAT) to predict 79 estimates.

Use 1976, 77, 79 data in MYGOAT to predict 78 estimates.

Use 1976, 78, 79 data in MYGOAT to predict 77 estimates.

Use 1977, 78, 79 data in MYGOAT to predict 76 estimates.

Use 1976, 77 data in MYGOAT to predict 79 estimates.

Use 1976, 77 data in MYGOAT to predict 78 estimates.

Use 1976, 78 data in MYGOAT to predict 79 estimates.

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Use 1977 data in MYGOAT to predict 79 estimates.

Use 1978 data in MYGOAT to predict 76 estimates.

Use 1978 data in MYGOAT to predict 77 estimates.

Use 1978 data in MYGOAT to predict 79 estimates.

Use 1979 data in MYGOAT to predict 76 estimates.

## PRELIMINARY EXPERIMENT DESIGN

Use 1979 data in MYGOAT to predict 77 estimates.

Use 1979 data in MYGOAT to predict 78 estimates.

- There are 28 combinations (seven combinations of years to predict each of the four years' aggregations).
- All statistics for the 28 combinations can be computed with only 10 runs of the MYGOAT.
- Aggregate for wheat, barley, and oats for combinations not containing 1976 data; otherwise, aggregate for wheat only.

### A.1.6 EVALUATIONS

#### A.1.6.1 FSR Segments

- For the baseline, determine the bias, standard deviation, and mean square error (MSE) of the proportion estimates and evaluate labeling accuracy.
- For the automated barley labeler, determine the effect on proportion estimation accuracy and labeling accuracy by a comparison to those of the baseline (configuration 2 compared to configuration 1).
- For the pasture filter, determine the additional effect of having no pasture filter on proportion estimation accuracy and labeling accuracy by a comparison to those when adding only the automated barley labeler (configuration 3 compared to configuration 2).
- For the automated pure-pixel identification module, determine the additional effect on proportion estimation accuracy and labeling accuracy by a comparison to those when adding only the automated barley labeler and no pasture filter (configuration 4 compared to configuration 3).
- For the automated acquisition selection, determine the additional effect on proportion estimation accuracy and labeling accuracy by a comparison to those when adding the automated barley labeler, no

## PRELIMINARY EXPERIMENT DESIGN

pasture filter, and the automated pure-pixel identification module (configuration 5 compared to configuration 4).

- For the-three category proportional Bayesian estimation technique, determine (a) the accuracy and precision when GT labels are input; (b) the effect in relation to random sampling and; (c) the effect of the Bayesian estimator by a comparison to the estimates of the proportional maximum likelihood estimator (MLE). Then construct a generalized beta prior, based on empirical results, and compare with the prior used.
- For the SSG4 (spatial/color sequence SSG) procedure, determine the accuracy and precision of proportion estimates.

For the dots used in the baseline but processed with field designations/labels of the SSG-4 procedure, the automated barley labeler and the three-category proportional Bayesian estimation technique, determine the accuracy/ precision of proportion estimates and the labeling accuracy. Compare these results with the SSG2 procedure results.

- For the error model, determine the accuracy/precision in estimating errors of the SSG2 procedure. Compare the results with those that were obtained in the development, using the SSG2 procedure for the United States to determine the effect of the adaptation (procedure not adapted to the U.S.S.R.).
- For the aggregations, determine the accuracy of areal estimates as compared to U.S. Department of Agriculture (USDA) estimates. Determine the effect that varying quantities of historical or multiyear data have on the decision of aggregated estimates.

### A.1.6.2 IR Segments

- For the adapted SSG2 procedure, determine the effect on proportion estimates because of no pasture filter.
- For the biowindow midpoint model, determine a quantitatively defined biowindow in terms of greenness and brightness, and compare with spectral biowindow model predictions.

## PRELIMINARY EXPERIMENT DESIGN

If the acquisition date falls outside the spectral biowindow, determine the deviation in days of the acquisition from the nearest endpoint of the window. Negative values indicate that the biowindow model predictions were early; positive values indicate they were late.

### A.1.7 QUESTIONS CONCERNING THE PROCEDURES

#### A.1.7.1 Reformatted Procedure

- What is the labeling accuracy of cropland/noncropland?
- What is the labeling accuracy of grain/nongrain?
- What percentage of grain is omitted to noncropland and what percentage of grain is omitted to nongrains?
- What are the sources of labeling errors?
  - Noncropland (water, pasture, etc.)
  - Nongrain (corn, soybeans, flax, etc.)
- Do labeling errors and their sources vary from one crop-mix region to another?
- Can certain logic paths in the labeling decision be associated with certain types of errors?
- Will a comparison of machine labels with the integrated analysis labels for IR segments show qualitative similarities with FSR segment results?

#### A.1.7.2 Reformatted Barley Procedure and the Automated Barley Procedure

- What is the labeling accuracy of barley?
- What is the relationship (with regard to labeling accuracy of barley) between the amount of barley relative to the amount of other small grains?

## PRELIMINARY EXPERIMENT DESIGN

- Would we do better to plot all SSG dots [i.e., (the number of SSG dots) x (number of segments)] on the same green number versus brightness plot for the purpose of separation?
- Would a linear discriminant function be superior to the fixed-slope approach to separation (reformatted only)?
- What percentage of barley is omitted as noncropland?
- What percentage of barley is omitted as nongrain?
- What percentage of barley is unseparable?
- What nongrain pixels are committed with barley?
- What is the nature of Q and V labels?
- How "definite" is definite barley and definite other small grains?
- Does labeling accuracy differ accross the crop-mix areas?
- Is increased accuracy achieved with 418 dots?

### A.1.7.3 Automated Boundary Pixel Selector

- How many boundary pixels are missed?
- How many boundary pixels are in interiors?
- Does the selector perform as well as the manual procedure and if not, is the selector still justified due to increased efficiency?
- What is the effect of the reporting level of historical data upon area estimation?
- What is the effect of limited historical data upon area estimation?
- What is the effect of limited multiyear data upon area estimation?
- What is the effect of cloud cover upon area estimation?
- What is the effect of the lack of precision of within-stratum variance estimates upon area estimation?

## PRELIMINARY EXPERIMENT DESIGN

### A.1.7.4 Spatial/Color Sequence Proportion Estimation

- What is the purity of the extracted fields?
- How closely do the extracted fields correspond to ground-truth fields?
- Which biowindow sequences tend to be the most accurate predictors of SSG, and what are the characteristics of those fields whose biowindow sequence is not a reliable predictor of SSG?
- How effective is the 2-4-4 biowindow sequence in the identification of barley?
- Of the small grains omitted, what percentage is barley?
- What biowindow sequences tend to lead to omission, and which tend to lead to commission?
- How does proportion estimation compare with Bayes proportion estimation?

### A.1.7.5 Bayes Estimation, Probability of Correct Classification/Exhaustive Search, and Probability of Correct Classification Adjustment for Label Errors

- General
  - What is the mean bias and its variance over all 25 FSR segments and within each crop-mix area?
  - What portion of the bias is due to labeling, to procedure, and to sampling?
  - What portion of the MSE is due to bias?
  - How do machine-generated proportion estimates compare to relative count?
  - How do these procedures compare?
- Probability of correct classification adjustment for label errors
  - How accurate are the labeling error estimates?

## PRELIMINARY EXPERIMENT DESIGN

### A.1.7.6 Error Model

- How does the predicted stratum level mean bias compare with the calculated stratum level mean bias?
- How does the predicted segment level error compare with the actual segment level error?
- Which level of estimation - segment or stratum - yields the most reliable and most useful estimate of proportion estimation error?

### A.1.7.7 Biowindow Midpoint Selection/Acquisition Selection Design

- Does the biowindow midpoint/acquisition selector assign acquisitions to the same biowindow as the subjective procedure?

### A.1.7.8 Overall Performance

- Given the performance of technology in the U.S.S.R. Barley Exploratory Experiment, what performance could be expected in the U.S.S.R. at the country level (yield, area, production)?
  - In accuracy
  - In precision
    - For winter grains
    - For spring grains
    - For all small grains
    - For barley

## TECHNOLOGY ASSESSMENT

### A.2 TECHNOLOGY ASSESSMENT

The SSG2 labeling procedure is presented in figure A-9.

#### A.2.1 ADAPTED SSG2 PROCEDURE

The SSG2 procedure performance results prior to the new adaptation were as follows:

- 30 segments, U.S. Northern Great Plains (USNGP), 1976-1979 (1981 U.S./Canada SSG Pilot Experiment)
  - Mean error = 2.0
  - Standard deviation = 7.35

Adapting the SSG procedure for application in the U.S.S.R. required solving some problems. This effort was proposed to compensate for the U.S.S.R. labeling difficulty. The problems and solutions are presented herein.

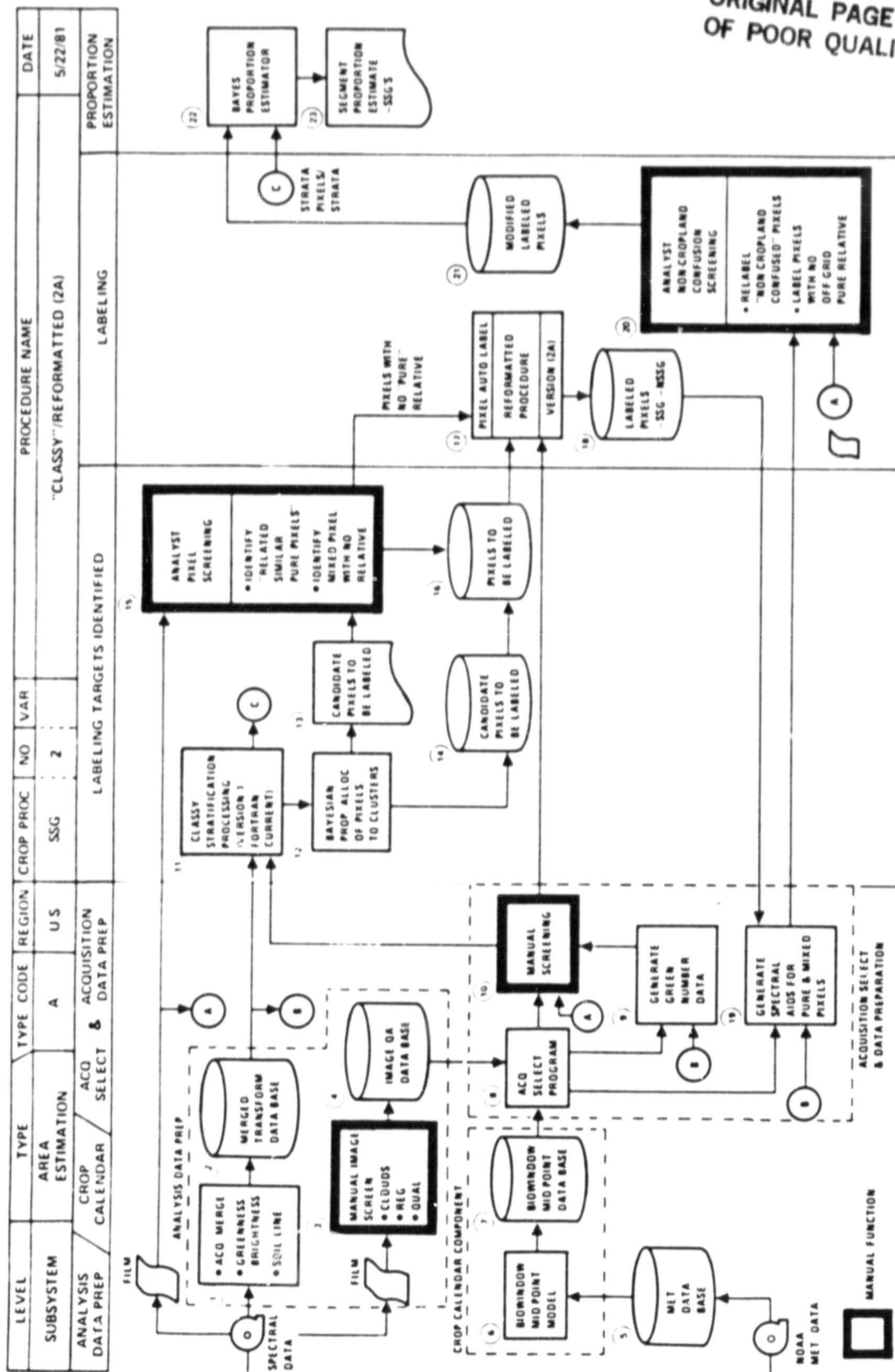
Proposed actions to compensate for U.S.S.R. labeling problems:

Problem #1: Commission of large numbers of winter grain dots to spring grain in the Belorussia, North Caucasus, and Central Regions.

Solution: The Belorussia and North Caucasus Regions require a Window 1 acquisition as part of the minimum data set for both the basic and augmented logic. In the Central Region where spring and winter grains are not separable, slight adjustment to the window midpoints is done to ensure the labeling of both winter and spring small grains; the SSG logic is used. Mathematical methods will be required to directly proportion the winter grains, spring grains, and barley in this region to determine the relative acreages.

Problem #2: Omission of large numbers of SSG dots in the Ural Region because of the 1977 drought (lack of "green-up").

# TECHNOLOGY ASSESSMENT



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Figure A-9.- The SSG2 labeling procedure flow chart.

## TECHNOLOGY ASSESSMENT

Solution: For the 1977 drought segments, in the Ural Region only, (a) lower the window 2 green number threshold from  $\geq 8$  to  $\geq 5$  in both the basic and augmented logic and (b) apply the augmented labeling logic first, omitting module C; process with basic logic only if not workable using this modified augmented logic.

Problem #3: Lack of barley separation in a single acquisition scatter plot (as previously observed in the United States). No knowledge of the effect of drought (Problem 2) on barley separation is also related.

Solution: Assume that all SSG in the North Caucasus Region is barley and aggregate accordingly. Separate barley in the Ural and Belorussia Regions using the dot drift version of the U.S. barley separation procedure where possible and treating all SSG dots as "Q" dots. Separate barley in the other segments by placing a line in the single acquisition plot by interpreting colors, using segments separated by the dot drift method in the same area for color reference.

Listed below are the detailed changes to the baseline labeling procedure:

### Belorussia Region

- Processing logic order of precedence:
  - Basic logic
  - Augmented logic
- Minimum data sets for basic logic:
  - Windows 1, 2, 3, 4
  - Windows 1, 2, 4
  - Windows 1, 3, 4

## TECHNOLOGY ASSESSMENT

- Changes in modules/data sets for augmented logic:
  - Shorten the length of time period 5 from 15 days to 8 days.
  - Delete option to process with time period 0; window 1 is required. Minimum data set becomes at least one acceptable acquisition from each of the following groups:
    - Group 1: window 1
    - Group 2: window 2, period 2-3, or window 3
    - Group 3: period 3A or period A

### Central Region

- Processing logic order of precedence:
  - basic logic
  - augmented logic
- Minimum data sets for basic logic:
  - windows 1, 2, 3, 4
  - windows 1, 2, 4
  - windows 1, 3, 4
- Changes in modules/data sets for augmented logic:
  - Shorten length of time period 5 from 15 days to 8 days
  - Minimum data set for augmented logic is at least one acceptable acquisition from each of the following groups:
    - Group 1: period 0, window 1, window 4 or period 5
    - Group 2: window 2, period 2-3 or window 3
    - Group 3: period 3A or period A
- Manual midpoint verification of each segment to assure accomodation of the variability of all small grains, both winter and spring. (This is a verification unique for this region.)

## TECHNOLOGY ASSESSMENT

- Barley separation procedure does not apply. Statistical methods will be required to arrive at a barley proportion.

### North Caucasus Region

- Processing logic order of precedence:
  - Basic logic
  - Augmented logic
- Minimum data sets for basic logic:
  - Windows 1, 2, 3, 4
  - Windows 1, 2, 4
  - Windows 1, 3, 4
- Changes in modules/data sets for augmented logic:
  - Shorten length of time period 5 from 15 days to 8 days.
  - Delete option to process with time period 0; window 1 is required. Minimum data set becomes at least one acceptable acquisition from each of the following groups:
    - Group 1: window 1
    - Group 2: window 2, period 2-3, or window 3
    - Group 3: period 3-A or period A
- Barley separation procedure is not applicable in this region. All spring small grains should be labeled barley.

### Ural Region

- Processing logic order of precedence (1977 crop year only):
  - Augmented logic
  - Basic logic
- For other crop years:
  - Basic logic
  - Augmented logic

## TECHNOLOGY ASSESSMENT

- Minimum data sets for basic logic:
  - Windows 1, 2, 3, 4
  - Windows 1, 2, 4
  - Windows 1, 3, 4
- Changes in modules/data sets for augmented logic:
  - Shorten length of time period 5 from 15 days to 8 days.
  - Process with either time period 0 or window 1; minimum data sets are as defined for the U.S. baseline procedure.
  - For 1977 segments in Chelyabinsk, Kurgan, and Orenburg Oblasts, bypass module C logic. This will partially compensate for drought effects in these areas.
  - For the 1977 crop year in Chelyabinsk, Kurgan, and Orenburg Oblasts, lower the green number threshold for window 2 in module G from  $\geq 8$  to  $\geq 5$ . This will partially compensate for drought effects in these areas.
- Barley separation procedure is applicable in this region.

Table A-3 presents the data derived when the new SSG2 procedure was applied to U.S.S.R. results.

TABLE A-3.- SSG2 PROCEDURE ADAPTATION TO U.S.S.R. RESULTS

Segment number	Logic	Region/oblast	Procedure SSG2	Adapted Procedure SSG2
7950	Augmented	Orenberg	0.00	2.12
7959	Augmented	Orenberg	-4.54	3.40
7973	Augmented	Orenberg	-8.23	-1.17
8021	Augmented	Chelyabinsk	-62.16	-8.10
7950	Basic	Orenberg	10.63	12.76
7959	Basic	Orenberg	0.00	15.90

## TECHNOLOGY ASSESSMENT

### A.2.2 THREE-CATEGORY PROPORTIONAL ALLOCATION/BAYESIAN ESTIMATOR PROPORTION ESTIMATION TECHNIQUE

#### A.2.2.1 General

- Barley proportion estimation by historical ratioing small grains estimates was found too inaccurate and requires accurate historical statistics.
- Previous techniques used machine proportion estimation for spring small grains-nonsmall spring grains and used the manual proportion estimation technique for barley-other small grains.
- The objective is to present a machine proportion estimation technique for simultaneously estimating, in one step, barley, other small grains, and nonsmall grains from direct barley-other small grains labels, requiring no additional analyst effort.

The following technique was generated:

- Scene stratified into clusters
- Sample dots allocated to clusters proportional to cluster size; dots randomly selected within a cluster
- Bayesian estimates of cluster level proportions  
Dirichlet prior (figures A-10 and A-11) were modeled on 19 segments.

$$F(\theta_B, \theta_S) = K_W \theta_B^a \theta_S^b (1 - \theta_B - \theta_S)^c$$

$$\theta_B \in [0, 1]$$

$$\theta_S \in [0, 1 - \theta_B]$$

$$-1 < a, b, c,$$

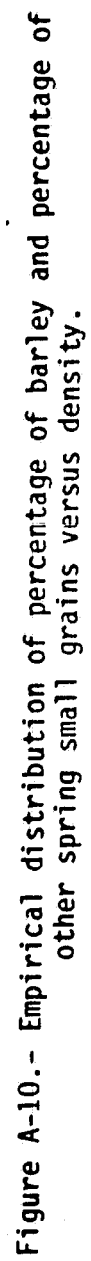
$$\hat{\theta}_B = \frac{B + a + 1}{N + a + b + c + 3}$$

$$\hat{\theta}_S = \frac{S + b + 1}{N + a + b + c + 3}$$

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- Aggregated to segment-level estimate by weighting cluster-level estimates by cluster size.

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# TECHNOLOGY ASSESSMENT

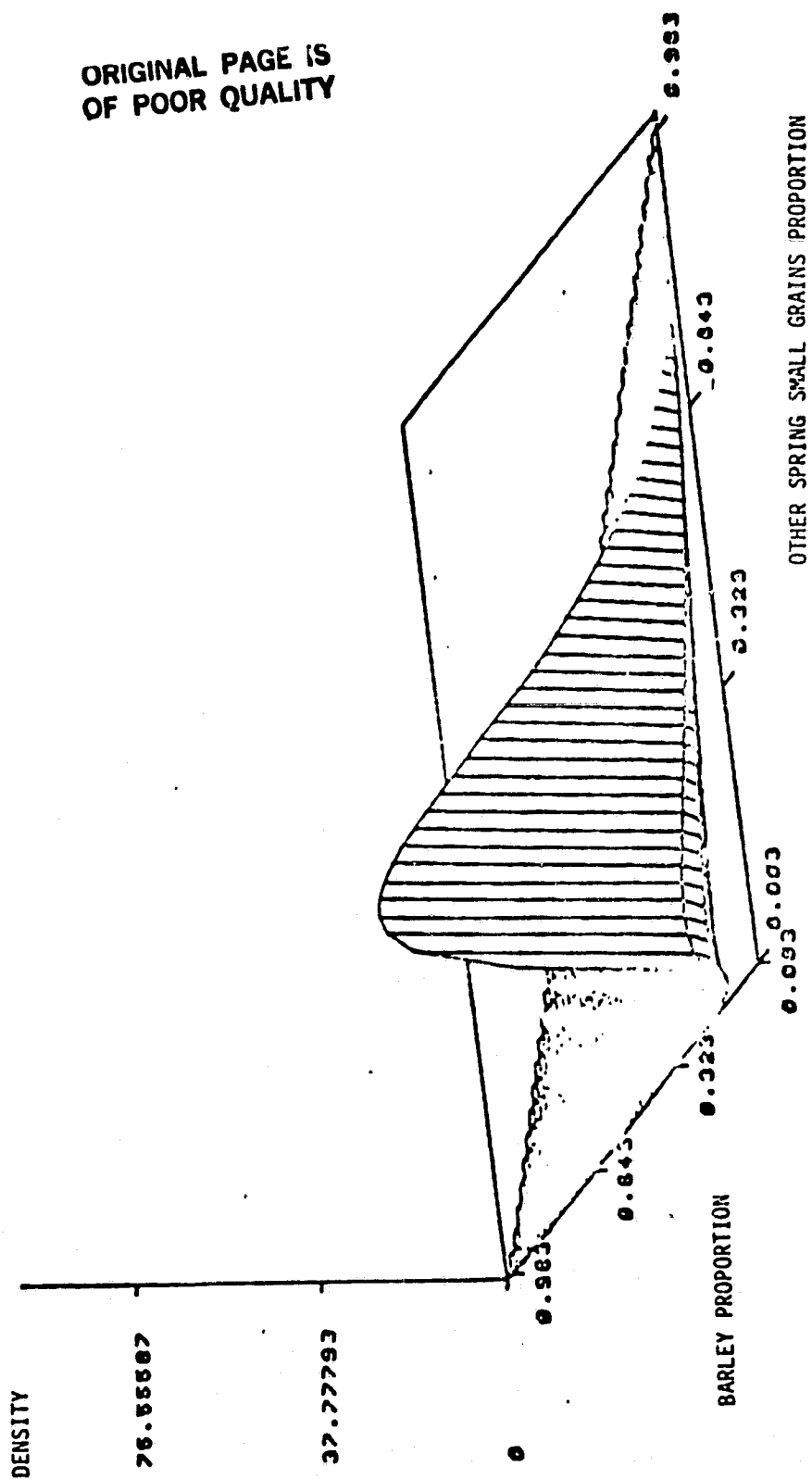


Figure A-11.- Dirichlet distribution of percentage of barley and percentage of other spring small grains versus density.

A.2.2.2 Three-Category Proportional Allocation/Bayesian Estimator (PA/BE)  
Test Results

## ● Two-category PA/BE technology

- Beta prior (figures A-12 and A-13) for cluster proportions

$$F(\theta_S) = K_1 \theta_S^a (1 - \theta_S)^b$$

$$\theta_S \in [0, 1]$$

$$-1 < a, b$$

$$\theta_S = \frac{s + a + 1}{N + a + b + 2}$$

## ● Two-category PA/BE performance

(1980 U.S./Canada Wheat and Barley Exploratory Experiment, 35 segments)

		Mean Error (%)	Se (%)
<u>AI labels</u> (Integrated procedure)	PA/BE	-3.5	6.0
	Random sampling	-5.7	7.7
<u>GT labels</u>	PA/BE	0.5	3.8
	Random sampling	-2.5	6.9

TECHNOLOGY ASSESSMENT

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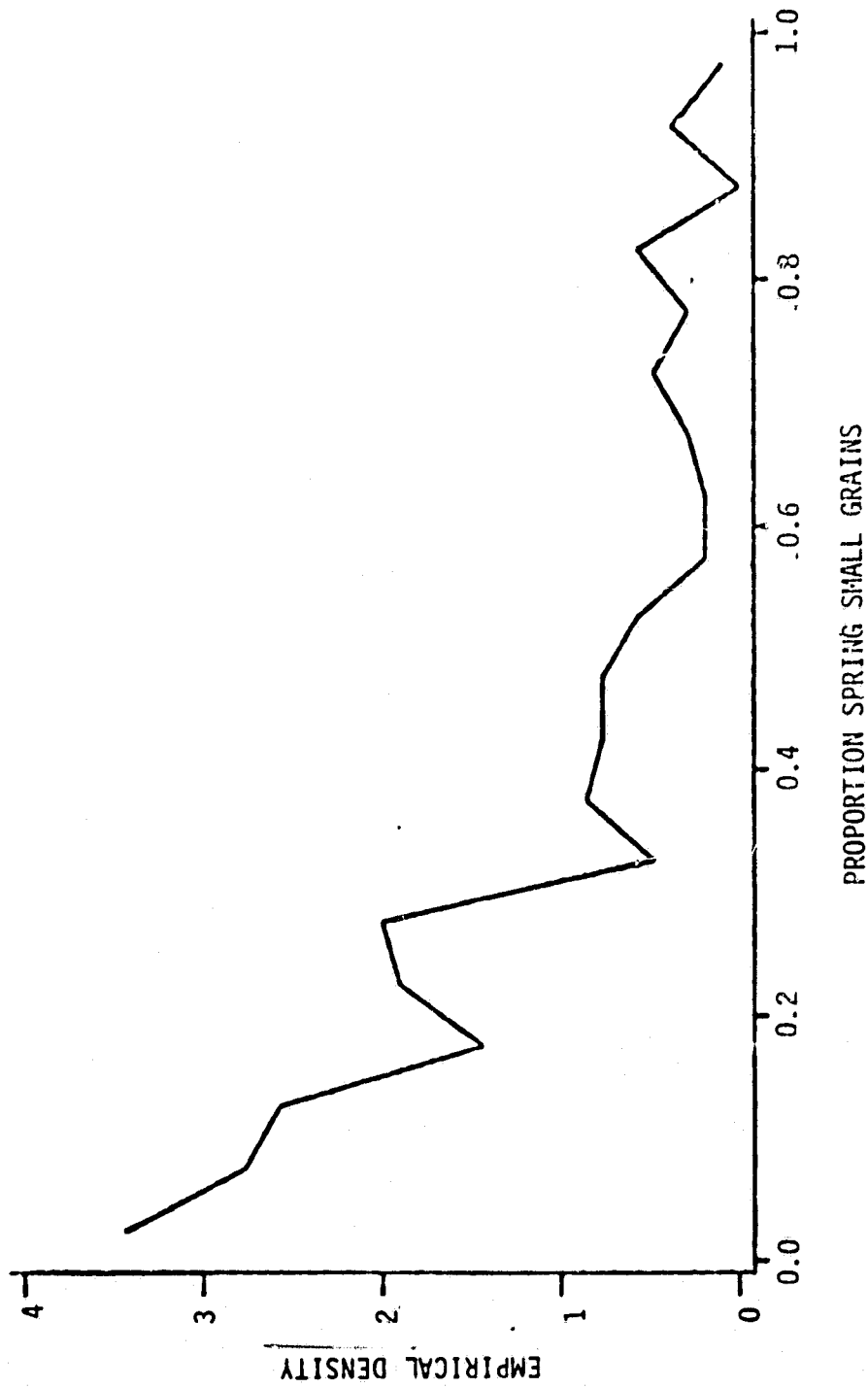


Figure A-12.- The empirical distribution of percentage  
of spring small grains versus density.

TECHNOLOGY ASSESSMENT

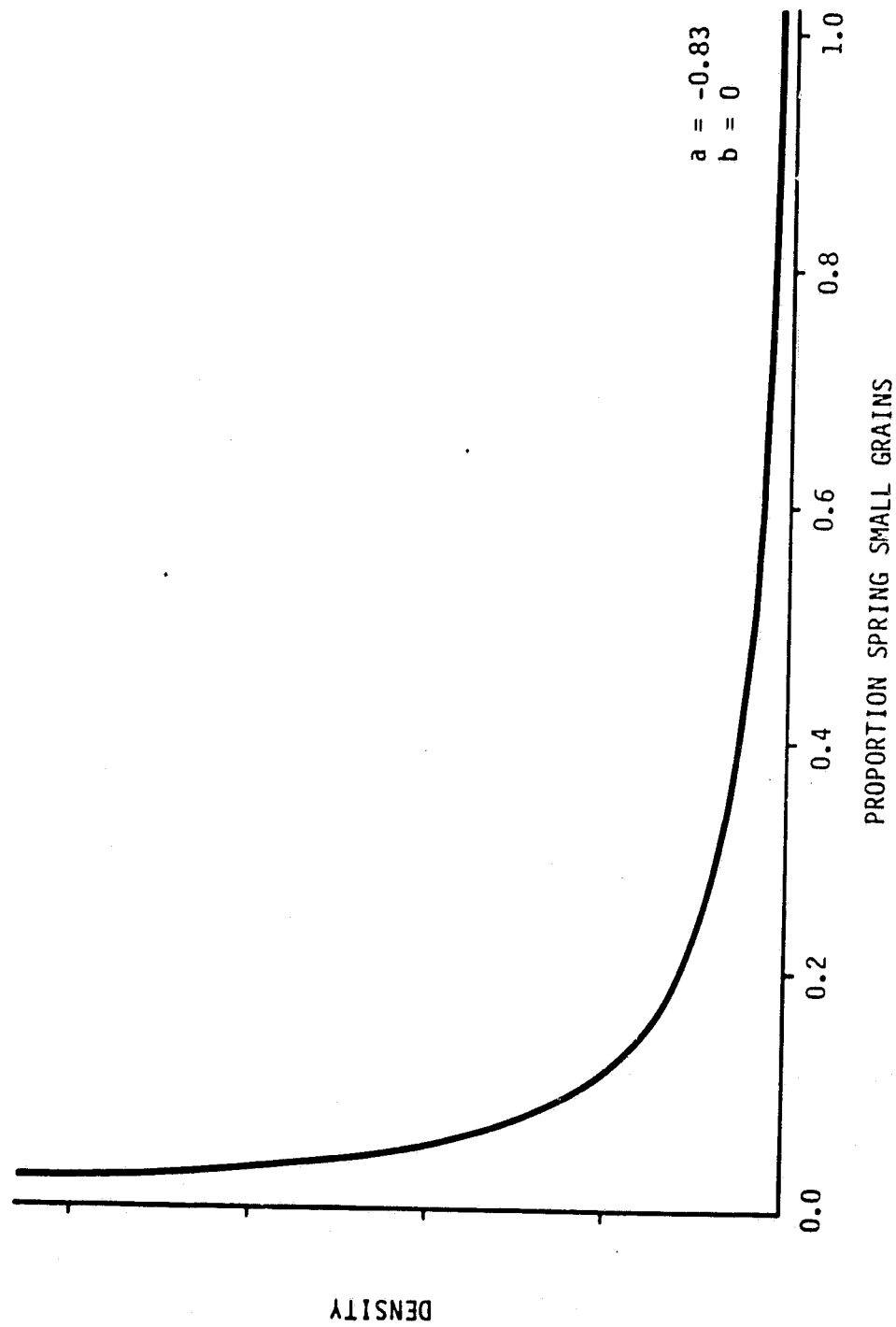


Figure A-13.- Beta distribution of percentage of spring small grains versus density.

## TECHNOLOGY ASSESSMENT

### A.2.3 SPECTROMET BARLEY/OTHER SPRING SMALL GRAINS DISCRIMINANT (AUTOMATED BARLEY LABELER) TECHNOLOGY (figure A-14)

- Background

- Spectral separation of barley from other spring small grains has been observed near the soft dough stage of spring wheat.
- Segment to segment variation in the position in feature space of the barley/other spring small grain discriminant line was hypothesized to be the result of the following.

- Acquisition history
- Meteorological stress
- Planting date distribution

Figures A-15 and A-16 show the overlap of barley and other spring small grains using Landsat data alone and with other meteorological data, respectively.

Figures A-17 through A-19 reflect estimates and percentages of barley in comparison studies. Table A-4 presents a summary of errors for barley proportion.

- Multivariate normal Bayes linear discriminant function

$$G_i(X) = -1/2 (S - \mu_i)^t \Sigma^{-1} (X - \mu_i) + \text{Log } P(W_i)$$

where

$G_i(X)$  = Discriminant function for  $i^{\text{th}}$  group

$X$  = Feature space vector

- Pixel value of greenness/brightness
- Accumulated degree day for date of acquisition

$\Sigma$  = Pooled covariance matrix

$\mu_i$  = Mean vector for the  $i^{\text{th}}$  group

$P(W_i)$  = a priori probability for the  $i^{\text{th}}$  group

# TECHNOLOGY ASSESSMENT

TABLE A-4.- SUMMARY OF ERRORS - BARLEY PROPORTION

		Ground truth, % barley		
		0 to 2.5	2.5 to 10.0	>10.0
Ground truth, % spring small grains	0 to 20.0	0.0 $\bar{X}$ 1.17 $S_X$ 5.0 N	0.7 $\bar{X}$ 1.02 $S_X$ 2.0 N	0.2 $\bar{X}$ .34 $S_X$ 2.0 N
	20.0 to 40.0		-.4 $\bar{X}$ 1.04 $S_X$ 5.0 N	
	>40.0			-5.9 $\bar{X}$ 0.73 $S_X$ 3.0 N

Overall: Mean error = 1.04

Standard deviation = 2.499

N = 17

# TECHNOLOGY ASSESSMENT

## SUBCOMPONENT FUNCTIONAL FLOW

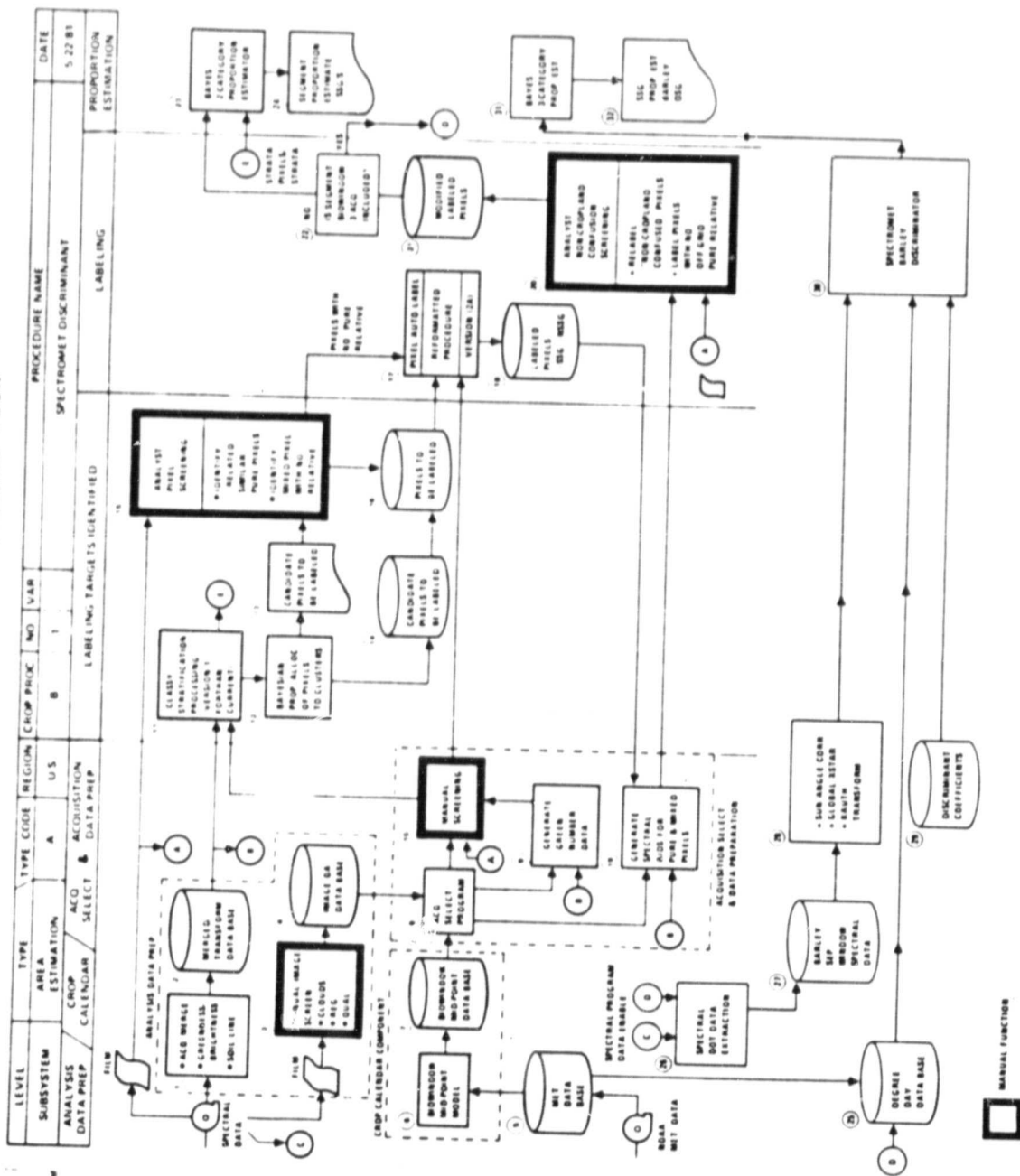


Figure A-14.- The flow diagram for the spectromet barley discriminant development.

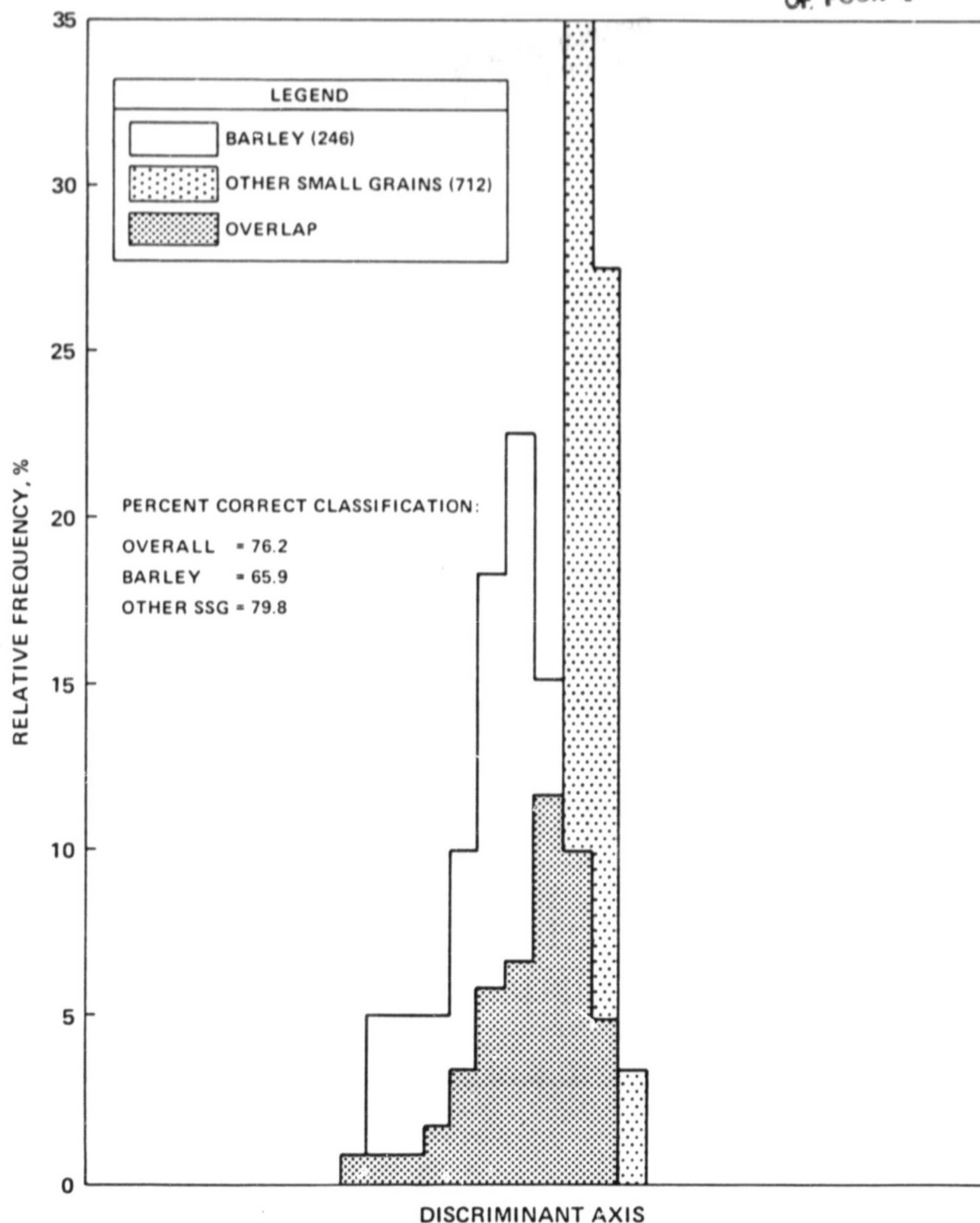


Figure A-15.- Overlap of barley and other spring small grains using Landsat data alone (normalized).

# TECHNOLOGY ASSESSMENT

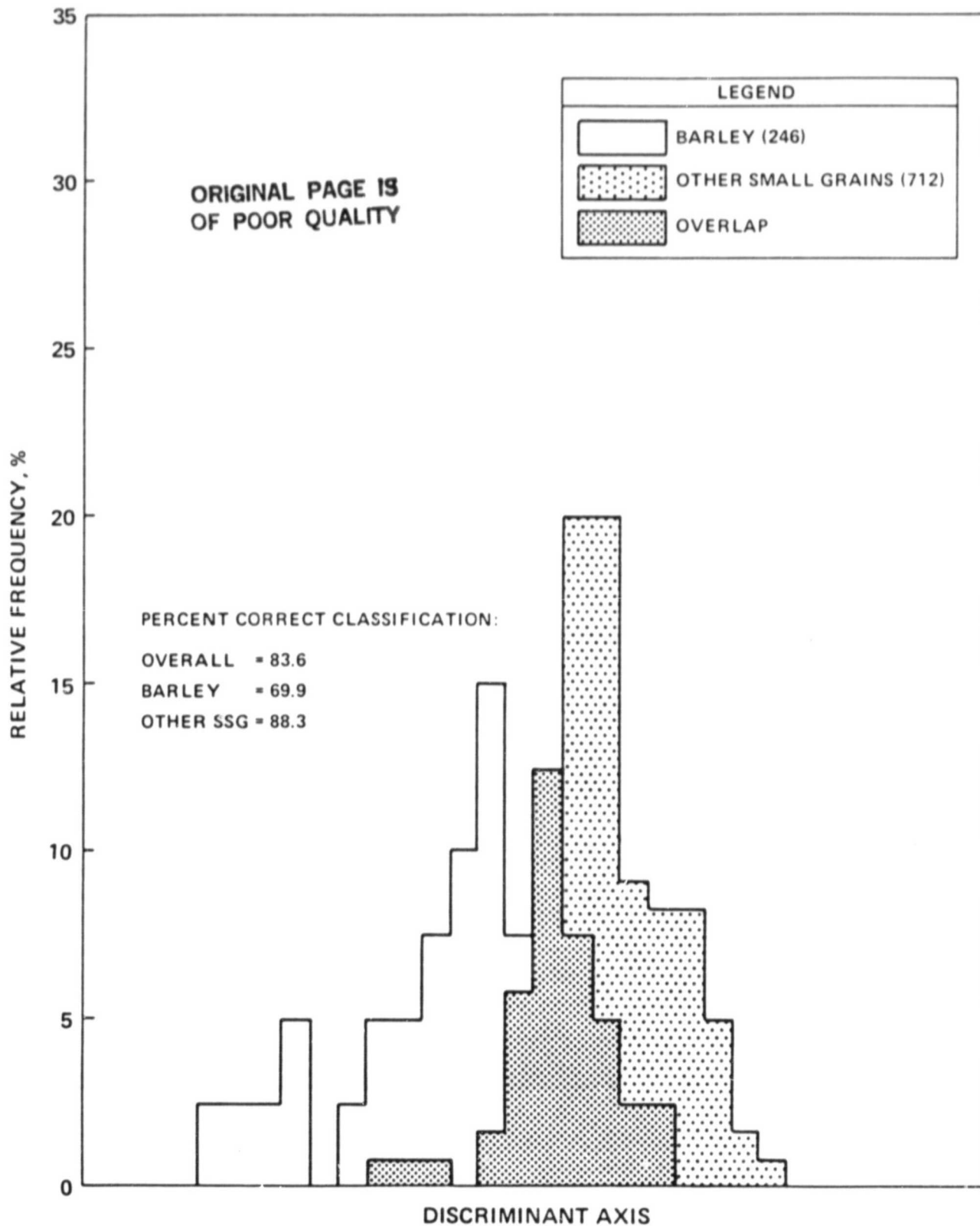


Figure A-16.- Overlap of barley and other spring small grains using Landsat and other meteorological data (normalized).

TECHNOLOGY ASSESSMENT

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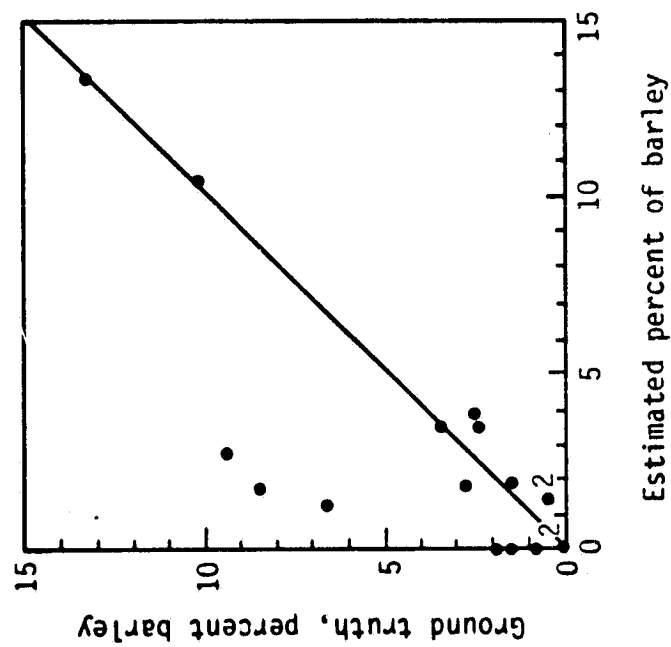


Figure A-17.- The predicted versus actual percent of barley - pure dot.

TECHNOLOGY ASSESSMENT

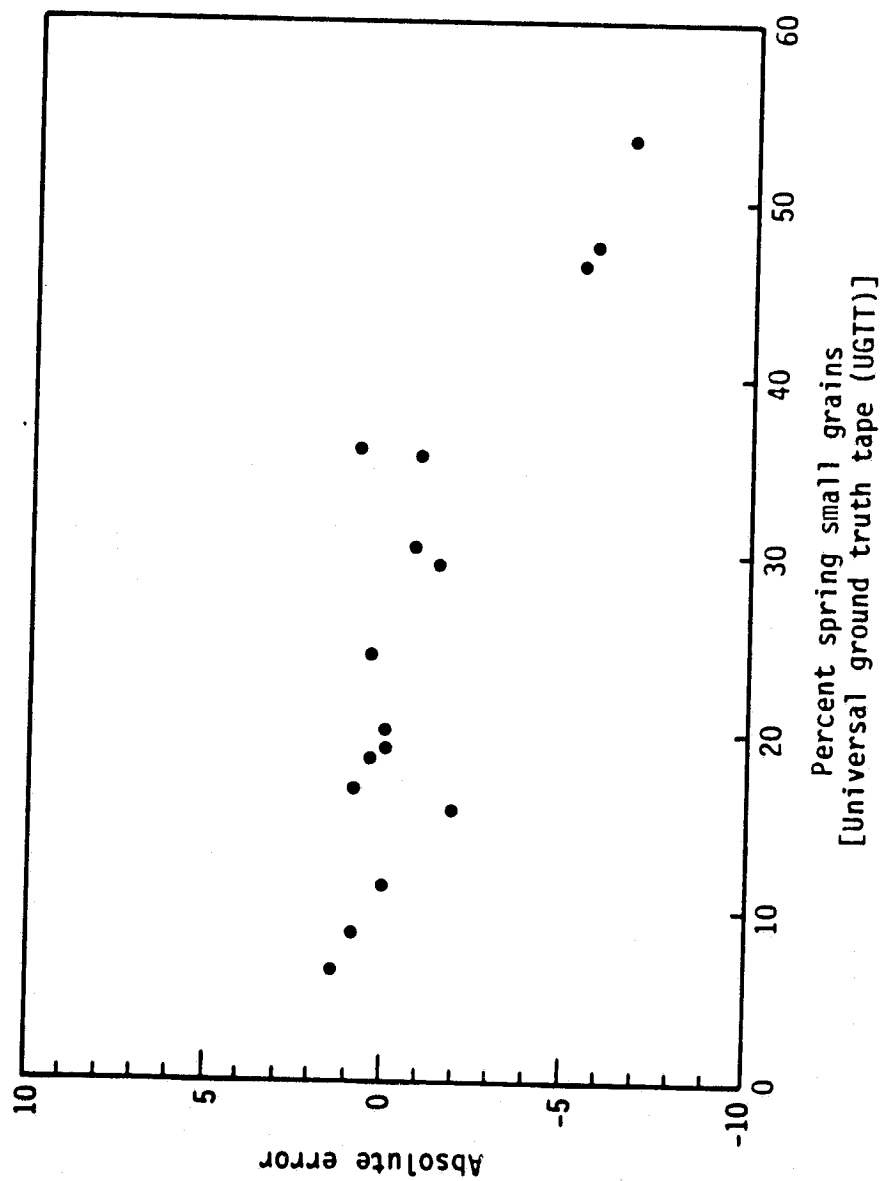
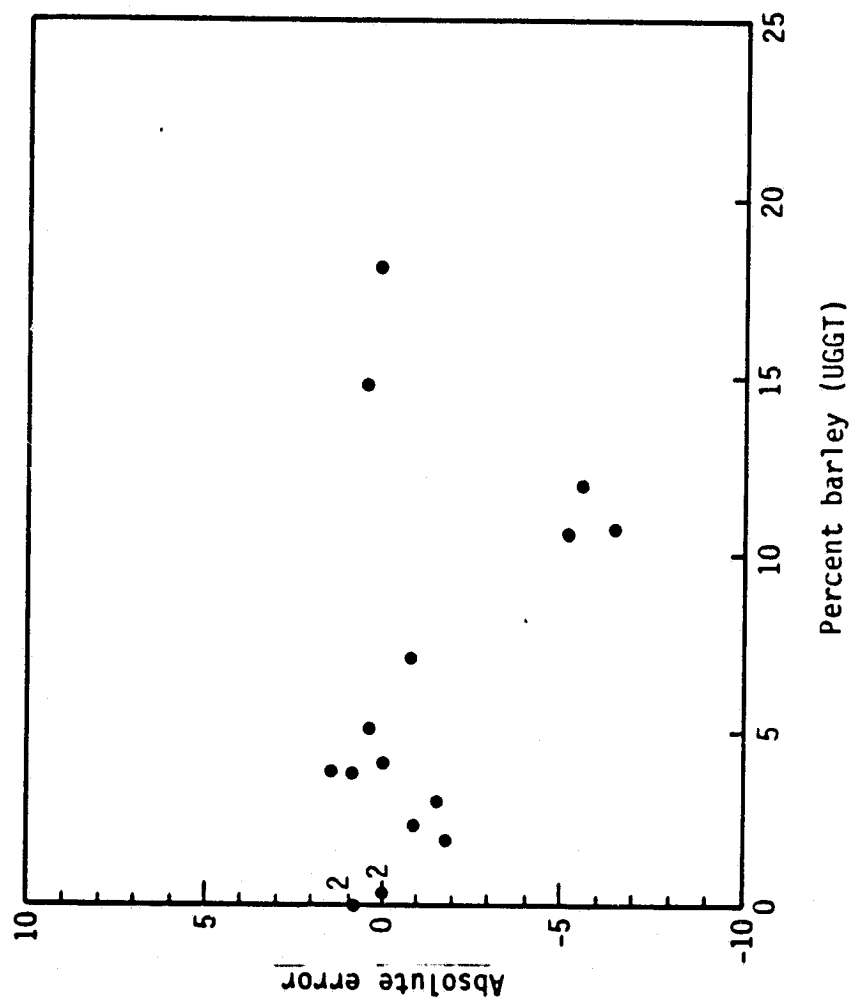


Figure A-18.- The spectromet barley proportion estimates, percent spring small grains.

TECHNOLOGY ASSESSMENT



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Figure A-19.- The spectromet barley proportion estimates, percent barley.

## TECHNOLOGY ASSESSMENT

### A.2.4 AUTOMATED PURE PIXEL SELECTION

- Labeling is to be done on pure pixels. When a boundary dot is encountered, an alternate pure dot is selected for labeling.
- Configuration of the automated procedure
  - Spatial/color sequence field delineation (pure and boundary pixel designations)
  - Alternate dot selection
    - Search area of 9 (fig. A-20)
    - Spectral tie option - selects the dot which is spectrally closest to original boundary dot
    - Adapted SSG2 labels for original boundary dot when a pure alternate is not found in the search area
- Automation proposed to reduce analyst input time
- Tested on 30 segments, USNGP, 1976-79

The results of the proportion estimation accuracy using 209 random samples and ground-truth labels follow:

- The automated alternate dot selection provides a representative sample.
- Table A-5 shows the unbiased proportion estimates when ground-truth labels are used for input.
- The selection of alternate dots is appropriate if 70 percent of the alternate dots had the same ground-truth crop code as their respective (boundary) grid dot.

The results of proportion estimation accuracy are in table A-6. Sixty dots (proportional allocation to CLASSY clusters/Bayesian estimator) and SSG2 labels (from automated labeling procedure with manual pasture filter) were used. SSG2 labels were used for automated selection of dots.

The comparison of analyst-selected dots with those selected by the automated procedure for SSG2 labeling accuracy are given in table A-7.

## TECHNOLOGY ASSESSMENT

TABLE A-5.- MEAN ERRORS BASED ON GROUND-TRUTH (GT) LABELS

Error	209 grid dots	209 grid/alternate dots	Pure grid dots
Mean error, %	-0.8	-0.6	-7.5
Standard deviation of errors, %	2.6	2.6	5.4

TABLE A-6.- MEAN ERRORS BASED ON ANALYST-SELECTED AND AUTO-SELECTED DOTS

Error	Analyst-interpreted	Automated selection
<sup>a</sup> Mean error	2.0	3.0
Standard deviation of the errors, %	7.35	7.61
Mean absolute error, %	5.9	6.7
Relative mean error, %	7.5	11.3
Mean GT proportion, %	26.6	26.6
Sample size, segments	30	30

<sup>a</sup>No significant difference between proportion estimates when automated pure pixels are labeled and proportion estimates when analyst pure pixels are labeled.

## TECHNOLOGY ASSESSMENT

TABLE A-7.- SSG2 LABELING ACCURACY COMPARISONS FOR ANALYST-SELECTED DOTS  
AND THOSE SELECTED BY THE AUTOMATED PROCEDURE

Dots, automated or analyst-interpreted		Small grains	Nonsmall grains	Overall (Both small and nonsmall grains)
Pure grid dots	<sup>a</sup> Automated	75.4	85.1	82.7
	<sup>b</sup> Analyst- interpreted	71.5	87.6	83.5
Alternate dots	Automated	66.9	82.1	78.3
	Analyst- interpreted	82.4	82.6	82.6
Total dots	Automated	73.3	84.4	81.6
	Analyst- interpreted	73.4	86.9	83.4

<sup>a</sup>24.5 percent of the grid dots were boundary dots according to the spatial/ color field delineation.

<sup>b</sup>14.5 percent of the grid dots were boundary dots according to the analysis.

**AUTOMATED PURE PIXEL  
SELECTION**

[illegible]

**Figure A-20.-** The numerical order of the groups of pixels to be searched.

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## TECHNOLOGY ASSESSMENT

### A.2.5 AUTOMATED ACQUISITION SELECTION

- The automated acquisition selection inputs include:

- Acquisition dates
- Cloud cover data
- Biowindow midpoints

- Acquisitions ranked in biowindow/periods

If more than one acquisition falls within a window/period, rank them as follows:

<u>Window/period</u>	<u>First choice</u>
1, 2, 3, A, 4	Closest to the middle of the window/period. (If two acquisitions are equidistant from the middle, the latest one is the first choice.)
0	Closest to window 1
1-2, 2-3	Closest to window 2
3-A	Closest to time period A
5	Closest to window 4

Ranking is performed automatically within the acquisition selection program.

- Acquisitions selected to meet the minimum data requirements for the basic decision logic
  - Seven (maximum) acquisitions selected are those ranked first within each biowindow and time period A.
  - Acquisitions are checked for cumulative obscured ground area.
  - Processability of a segment based on acquisitions depends on the biowindows acquisition being in the geographic location of the segment.
- Acquisitions selected to meet minimum data requirements for the augmented decision logic

The minimum data required for spring small grains processing using the augmented branch are at least one acquisition from each of the following

## TECHNOLOGY ASSESSMENT

three groups: (1) group 1 includes period 0, window 1, window 4, and period 5; (2) group 2 includes window 2, period 2-3, and window 3; and (3) group 3 includes period 3-A and time period A. In winter wheat areas such as Montana and South Dakota, an acquisition in period 0 or window 1 is required.

- Six (maximum) acquisitions selected in specific order

- Select the maximum number of midseason acquisitions available (up to 3) in the following order: window 3, window 2, period 3-A, period 1-2, and period 2-3.
- Select the maximum number of late season acquisitions available [up to 2 (three minus the total number of acquisitions already selected)] in the following order: window 4, time period A, period 5, and additional time period A.
- Select the maximum number of early season acquisitions available [up to (6 minus the total number of acquisitions already selected)] in the following order: window 1 and period 0.

If the total number of acquisitions selected is less than 6, select the maximum number of additional acquisitions available [up to (6 minus the total number of acquisitions already selected)] in the following order (if not previously selected): period 1-2, period 5, and additional time period A.

- Acquisitions checked for combined obscured ground area. (Obscurity must be less than 40 percent.)

- A segment is processible if it is processible by either augmented or basic decision logic. If processible by both, the basic decision logic is used.

## TECHNOLOGY ASSESSMENT

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### A.2.6 BIOWINDOW MIDPOINT MODEL

- Uses daily minimum and maximum temperatures to calculate growing degree days (GDD)
- Biowindow midpoints are defined by particular GDD values (figure A-21). The Julian date at which the biowindow GDD value is attained is then used for defining opening and closing dates of the biowindow.
- Biowindow definition for the basic decision logic

Biowindow midpoints output from the crop calendar model are used to determine the opening and closing dates for each of the four biowindows as follows:

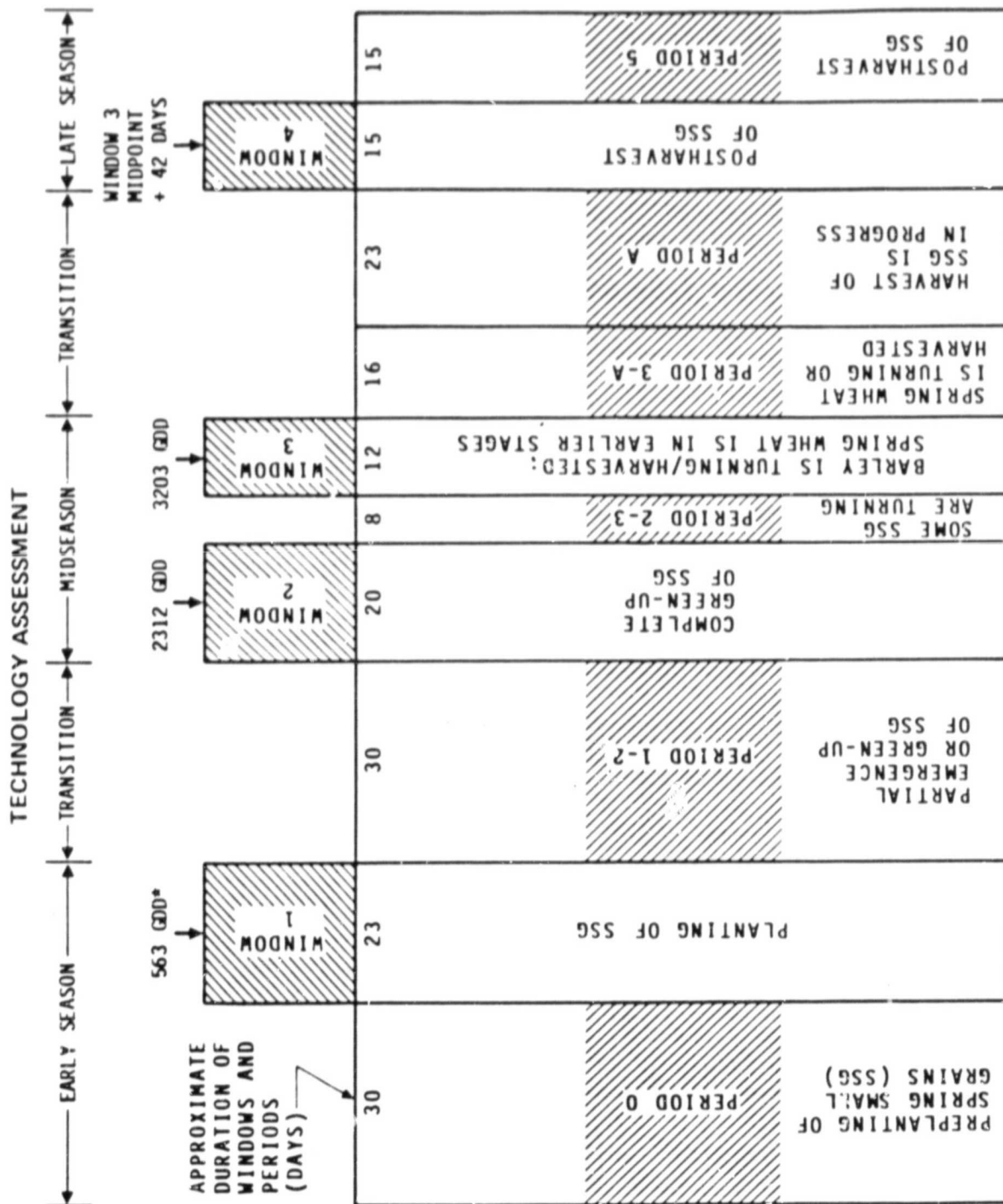
<u>Bio- window</u>	<u>Opening date</u>	<u>Closing date</u>	<u>Duration, days</u>
1	Spring wheat, 50% planted minus 5 days	Spring wheat, 50% planted plus 18 days	23
2	Spring wheat, 50% headed minus 10 days	Spring wheat, 50% headed plus 10 days	20
3	Spring barley, 50% turning-to- ripe minus 6 days	Spring barley, 50% turning-to- ripe plus 6 days	12
4	Spring wheat, 50% harvested plus 15 days	Spring wheat, 50% harvested plus 30 days	15

The basic branch's decision logic also utilizes acquisitions from time period A. The opening date of time period A is calculated as follows:

$$\begin{aligned} \text{Time period A} &= \left( \begin{array}{c} \text{biowindow 4} \\ \text{opening date} \end{array} \right) - \left( \begin{array}{c} \text{biowindow 3} \\ \text{closing date} \end{array} \right) \\ &\quad (0.4) \quad + \left( \begin{array}{c} \text{Biowindow 3} \\ \text{closing date} \end{array} \right) \end{aligned}$$

$$\text{Time period A ending date} = (\text{opening date of biowindow 4})$$

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\*GDD = Growing degree days with base 32°F.

Figure A-21.- The relationship between window/periods used in procedures SSG3B and SSG3C.

- Biowindow definitions for the augmented decision logic

The augmented branch's decision logic uses acquisitions within the remaining interim periods, a 30-day period preceding biowindow 1 (period 0) and a 15-day period following biowindow 4 (period 5). Period 1-2 spans the time from the closing date of biowindow 1 to the opening date of biowindow 2. Period 2-3 is the time between biowindows 2 and 3; period 3-A is the time between biowindow 3 and time period A. The biowindows and periods have been grouped into early-season, midseason, and late-season acquisitions.

- The FY 1980 U.S. Wheat/Barley Exploratory Experiment data include 49 spring wheat ground-truth segments from crop year 1979.

- Results of the experiment follow: the best planting date and crop growth stage models correctly assigned acquisitions to biowindows 1 and 2 seventy-three (73) percent of the time and to biowindow 3 twenty-one (21) percent of the time; no test was done for biowindow 4.

- Data for the Shakedown Test of the U.S./Canada Spring Small Grains Pilot Experiment include 15 ground-truth segments from crop years 1976-79.

- Evaluation results of biowindow midpoint models (tables A-8, A-9, and figure A-22)

●● Model form:

	<u>Supporting Research</u>	<u>Alternative (automated)</u>
Bias	4.7	2.8
Root mean square error (RMSE)	10.8	8.4

(Results are similar for all windows.)

- Alternative model form recommended, with analyst adjustment, for use in the baseline procedure SSG2 system in the U.S./Canada Spring Small Grains Pilot Experiment.
- The use of spring small grain window midpoints versus wheat window midpoints

# TECHNOLOGY ASSESSMENT

TABLE A-8.- SUMMER CROP COMMISSION

Year	Region	Oblast	Segment	Procedure	Number SSG dates	Number summer dots	Summer commission	Summer commission/ SSG
1976	Belorussia North	Minsk	7026	Basic	28	18	0	0
1977		Rostov	7388	Augmented	44	23	3	0.07
	Central Urals	Rostov	7390	Augmented	45	38	0	0
		Kalkmyk	7336	Basic	33	2	1	.06
		Ryazan	7574	Augmented	47	27	4	.09
		Baskir	7911	Augmented	75	12	0	0
		Baskir	7911	Basic			1	.01
		Orenberg	7950	Augmented	47	15	4	.09
		Orenberg	7950	Basic			6	.13
		Orenberg	7959	Augmented	89	11	0	0
		Orenberg	7959	Basic			0	0
		Chelyabinsk	7973	Augmented	83	6	1	.01
		Chelyabinsk	8021	Augmented	40	15	0	0
		Baskir	7902	Augmented	42	6	0	0
		Orenberg	7954	Augmented	114	28	0	0
		Chelyabinsk	8013	Augmented				
1978	Urals	Kurgan	8030	Augmented	53	5	5	.09

# TECHNOLOGY ASSESSMENT

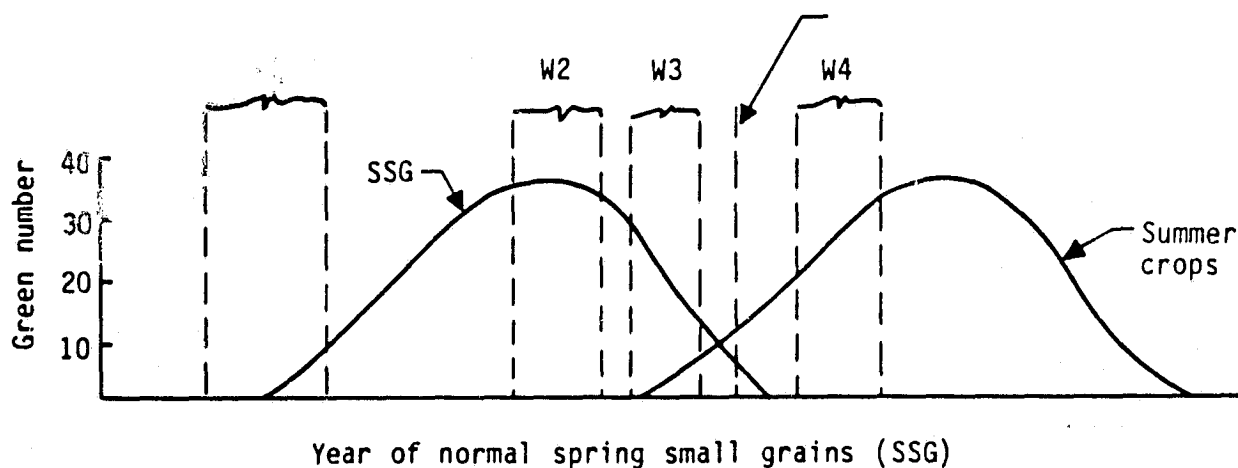
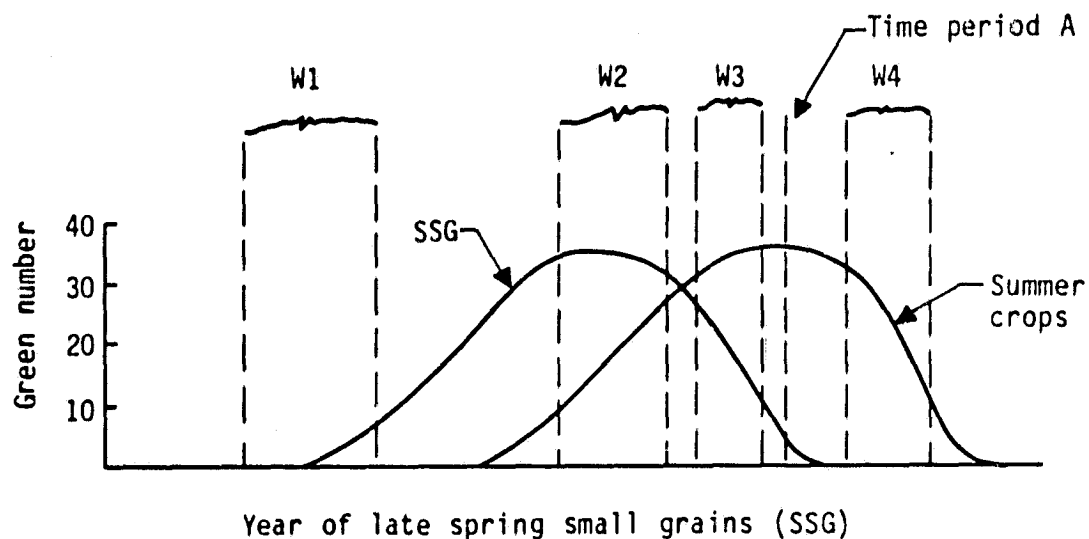
TABLE A-9.- SSG ACCURACIES TO DATE

Year	Region	Segment	Accuracy, %	Logic
1976	Belorussia	7026	75.0	Basic
1977	North Caucasus	7388	90.9	Augmented
		7336	100.0	Basic
		7390	66.7	Augmented
	Central	7574	100	Augmented
	Urals	7911	100	Basic
	Orenberg	7950	93.6	Augmented
			97.9	Basic
		7959	89.8	Basic
			95.5	Augmented
		7973	90.6	Augmented
		8021	37.8	Augmented
1978	Urals	7902	80.95	Augmented
		7954	95.5	Augmented
		8013		
	U.S.S.R	8030	71.70	Augmented
		Overall	92.5	Basic
			85.3	Augmented
	Canada	1958	100.0	Basic
		3053	74.2	Augmented
		3175	97.1	Basic
		Overall	98.6	Basic
			74.2	Augmented

# TECHNOLOGY ASSESSMENT

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## BIOWINDOW MIDPOINT MODEL



- In years of late SSG, summer crops are committed in window (W) 2, and period A is needed to screen them out.
- In a year of normal spring grains, summer crops are not generally committed; but if so, the summer crops will be screened out by W4.

Figure A-22.- Window estimates of spring small grains.

## TECHNOLOGY ASSESSMENT

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- Comparison of the selected FSR segments for window 2 midpoint showed no significant difference between the wheat midpoint and the midpoint for a grain mixture.
- Comparison of the two methods using a U.S. segment with more than 30 percent barley (almost all early maturing) showed no difference in windows 1 and 2 and showed a 1-day difference in windows 3 and 4.
- Very little early barley separation has been observed in the U.S.S.R. segments, which would tend to cause window midpoints to be too early.
- Problems indicated from U.S.S.R. segments in experimental processing
  - Major impact on labeling:
    - Commission of noncropland
    - Winter wheat commission (lack of proper acquisitions)
    - Omission of spring small grains because of insufficient green-up caused by poor stands, poor soil, etc.
    - Possible window-finder failure in short spring small grains growing season of North Caucasus Region or because of year-to-year variability.
  - Minor impact on labeling:
    - Summer crop commission
    - Rapeseed commission in Canadian segments
- Winter grain commission
  - Winter grain is in 12 of 14 U.S.S.R. segments; content is as high as 108 dots; commission is as high as 37 dots; logic for software is under study.
- Spring crop commission
  - Five U.S.S.R. segments with nongrain spring crops; maximum dots committed to spring grains using current logic are 8 (probably potatoes).

## TECHNOLOGY ASSESSMENT

- Two Canadian segments with rapeseed: segment 3175 has three dots, two of which are committed to spring grain. Crop Year 1958 has 38 dots, 35 of which are committed to spring grain. (See no potential software solution.)
- Potential 1977 drought effects
  - Could result in serious (50-67%) omission of spring small grains in 10 to 25 segments in the North East Urals
  - Some effect (10 percent or more omission) of spring small grains on as many as 33 percent of the Ural segments.
  - Possible obscuration of any barley separation that might otherwise occur in 50 percent or more of the Ural segments.
- Data Assessment
  - Bellorussia, 50 percent as much potatoes as spring small grains
  - Central Region, 22 percent as much potatoes as spring small grains

## TECHNOLOGY ASSESSMENT

### A.2.7 SPATIAL/COLOR SEQUENCE (SSG4) PROCEDURE

Figure A-23 is the spring small grains spatial/color sequence procedure (SSG4).

- The developmental evaluation of procedure SSG4 data includes 13 segments from crop years 1978 and 1979, which the integrated procedure and procedure SSG4 have in common.
- Results of the proportion estimation evaluations (table A-10)
  - There is little difference between the MSE of the SSG4 procedure and the integrated procedure.
  - The bias of SSG4 is substantially smaller than the bias of the integrated procedure.

TABLE A-10.- PERFORMANCE COMPARISON OF INTEGRATED AND SSG4 PROCEDURES

Technology	MSE	Bias	Standard deviation
Integrated	40.32	-5.0	4.07
SSG4	49.56	-2.0	7.03

LEVEL	TYPE	TYPE CODE	REGION	CROP PROC	NO	VAR	PROCEDURE NAME	DATE
SUBSYSTEM	AREA ESTIMATION	A	US	SSG	4		SPATIAL/COLOR SEQUENCE	5/22/81
ANALYSIS DATA PREP	CROP CALENDAR	ACO SELECT & DATA PREP	LABELING TARGETS IDENTIFIED				LABELING	PROPORTION ESTIMATION

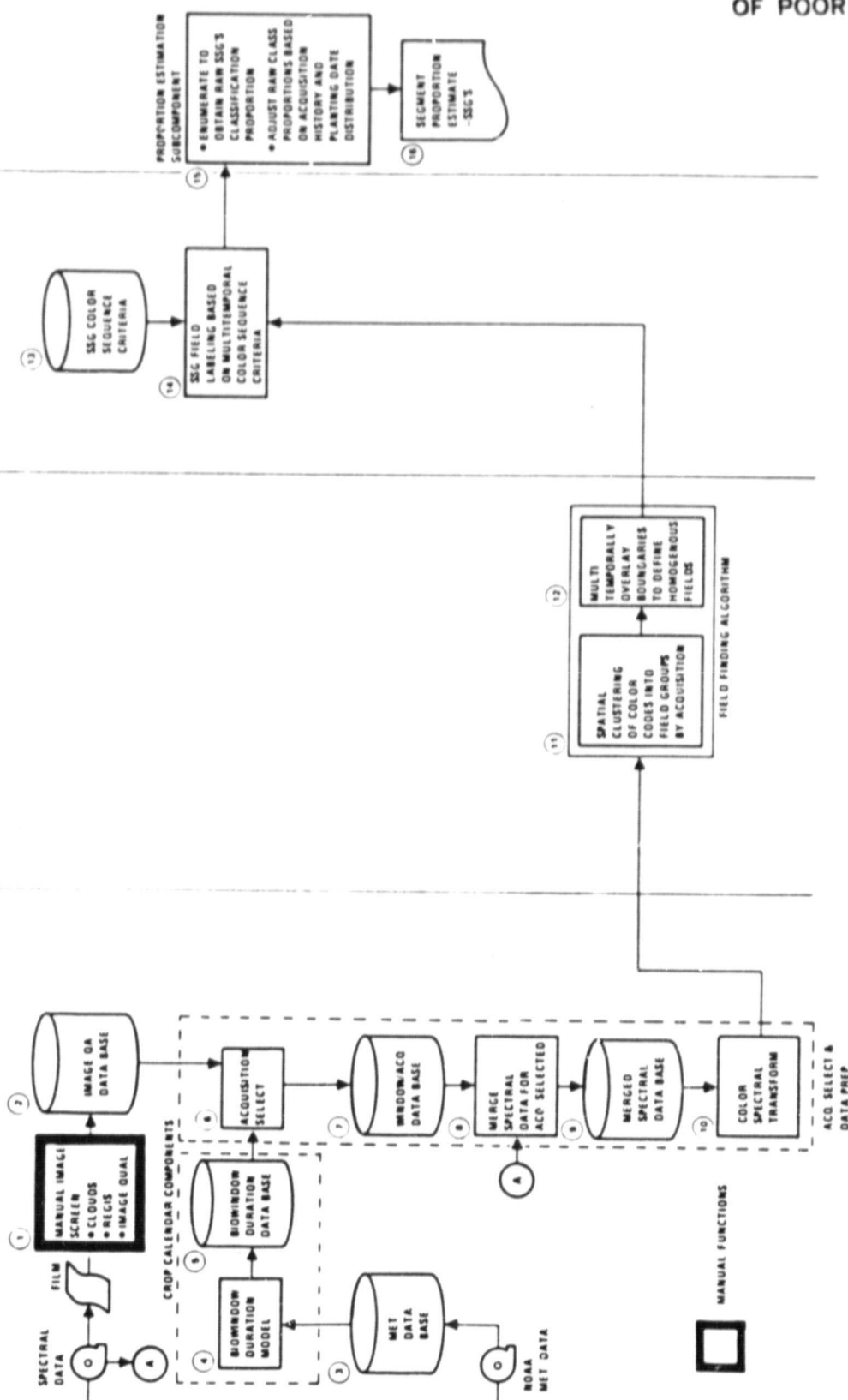


Figure A-23.- The SSG4 spatial/color sequence procedure flow chart.

## TECHNOLOGY ASSESSMENT

### A.2.8 ERROR MODELS

- Error models are quantified predictors of proportion estimation performance.
- The models' primary purpose is to evaluate the performance in foreign areas with limited ground observations.
- The models substitute for ground truth or maximal analysis.
- Error models are useful in analysis and improvement of proportion estimation technology.
- Current approach to error modeling (fig. A-24)
  - Gather performance data on all blind site segments except FSR
  - Develop data on all quantifiable sources of error
  - Construct model using half of data available
  - Validate model using other half
  - Test model in FSR
  - Apply model in IR
- Categories of error model variables
  - Field characteristics
  - Crop-mix estimates
  - Acquisition histories
  - Meteorological effects
  - Crop-growth stage variability
- Error models - conclusions from preliminary modeling activity (table A-11)
  - Prediction at segment-level is difficult.
  - Prediction at higher-level appears feasible.

# TECHNOLOGY ASSESSMENT

TABLE A-11.- PRELIMINARY ERROR MODEL RESULTS FOR 1978

SEGMENT LEVEL (N = 31)

<u>Dependent Variables</u>	<u>Independent Variables</u>	<u>Mean R<sup>2</sup></u>
Integrated omission rate	Integrated proportion estimate	0.48
Integrated commission rate	Automated proportion estimate	
Integrated proportion bias	Mean size SSG fields	
Automated proportion bias	Planting period duration	

Comments:

- Many combinations illogical
- Little pattern among models

APU (STRATUM) LEVEL (N = 6)

<u>Dependent Variables</u>	<u>Independent Variables</u>	<u>Mean R<sup>2</sup></u>
Integrated omission rate	Lateness of last acquisition	0.90
Integrated commission rate	Moisture jointing - heading	
Integrated proportion bias	Number of fields in segment	
Automated proportion bias	Percent fallow + pasture signature	
Integrated RMSE	Mean size SSG fields	
Automated RMSE		

Comments:

- Most combinations logical
- Integrated and automated bias models similar

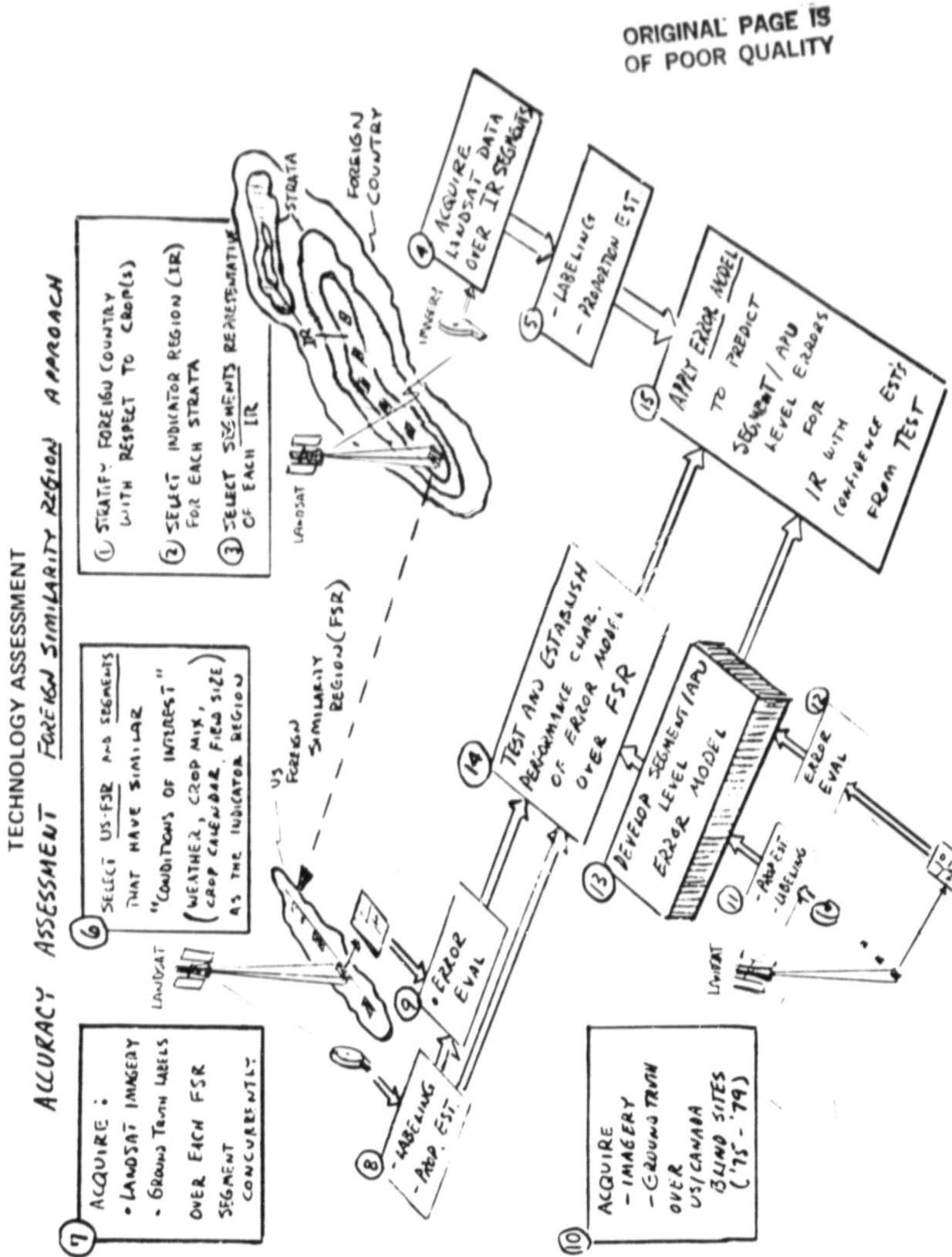


Figure A-24.- Accuracy assessment, FSR approach.

# TECHNOLOGY ASSESSMENT

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## A.2.9 HISTORICAL PROPORTION ESTIMATION

Table A-12 presents the historical proportion estimates.

TABLE A-12.- HISTORICAL PROPORTION ESTIMATES (INTEGRATED LABELING)

Crop	$\bar{\hat{x}}$	$\bar{x}$	$\bar{D}$	$S_{\bar{D}}$	N	SIGNIFICANCE
Winter small grains: LACIE, Phase III	22.9	27.7	-4.8	0.8	90	*
Winter wheat: LACIE, Phase III	22.0	25.1	-3.1	0.7	91	*
TY, Early season (Feb.)	19.2	23.7	-4.5	1.1	51	*
TY, After harvest	14.2	15.1	-0.9	0.6	56	
Spring small grains: LACIE, Phase III	28.8	34.9	-6.1	0.8	45	*
TY	24.7	28.7	-4.0	1.2	38	*
TY, less barley	23.6	28.6	-5.0	1.1	38	*
TY, barley	3.5	4.6	-1.1	0.6	38	*
1980 Exploratory Experiment (Proportional Bayesian, integrated labels)	(-)	(-)	-3.5	1.0	35	*
(Proportional Bayesian, reformatted labels)			6.0	5.5	9	
Development test (SSG)						
Spring wheat: LACIE, Phase III	16.1	19.3	-3.2	0.8	53	*
TY	15.5	19.9	-4.4	1.0	38	*

Symbol definition:

$$\bar{D} = \bar{\hat{x}} - \bar{x}$$

N = Sample size

$S_{\bar{D}}$  = Standard deviation of  $\bar{D}$

$\bar{\hat{x}}$  = Average harvested proportion estimate

$\bar{x}$  = Average ground-truth proportion estimate

\* = Indicates that the estimate was significantly different from the ground-truth proportion ( $\alpha = 0.10$ ).

## A.2.10 HISTORICAL LABELING ACCURACY

Table A-13 presents the historical labeling accuracy.

## • Labeling summary

- Accurate spring small grains labeling can be obtained for individual U.S.S.R. segments with slight adaptations to the baseline procedure. Similar results are attainable for segments in FSR's.
- Barley separation in the U.S.S.R. is not comparable to that observed in the U.S.
- There is large variability in the confidence associated with barley separation.

# TECHNOLOGY ASSESSMENT

TABLE A-13.- HISTORICAL LABELING ACCURACY

Crop	Experiment	Accuracy, %
Integrated Procedure		
Spring small grains	Lacie, Phase III	62
	Transition Year	73
	1980 Exploratory Experiment	80
Barley	Transition year	<sup>a</sup> 50
	1980 Exploratory Experiment	57
ERIM		
Barley	Phase II	72
	Phase III	86
Reformatted Procedure		
Spring small grains	1980 Exploratory Experiment	77
Barley	1980 Exploratory Experiment	51
	Spatial/Color SSG Procedure	
Spring small grains	Development Test	<sup>b</sup> 66

<sup>a</sup>Barley was separated from correctly labeled spring small grains at a 63-percent success rate; includes winter wheat.

<sup>b</sup>This is low by design since the procedure is a proportion estimation procedure rather than a labeling procedure; includes winter wheat.

## TECHNOLOGY ASSESSMENT

### A.2.11 AGGREGATION TECHNIQUES (figure A-25)

- Evaluation of Grouped Optimal Aggregation Technique (GOAT)
  - GOAT represents at least two distinct improvements over LACIE technology; see figure A-26.
    - GOAT considers acreage estimate for each stratum to be a linear combination of direct and ratio estimates. (In both cases, ratioing is done based on historical data, but GOAT permits use of multiple years of historical data; in LACIE, only one historical year was used.
    - When ratioing was performed in LACIE, ratios were based on arbitrary collections of strata. GOAT finds optimal grouping for determining ratios.
  - Simulation studies indicate the following.
    - GOAT has no procedural bias.
    - GOAT is robust against missing data.
    - GOAT provides good estimates of variance.
- Improvements over LACIE technology
  - In LACIE, stratum-level acreage proportion estimates were exclusively on current year segment proportion estimates, even for strata containing only one segment.
  - Multiyear (MY) mode considers acreage proportion estimates for each stratum to be a function of both current and previous year direct estimates (fig. A-27).
- Preliminary results
  - Tests with use of three years of North Dakota wheat data indicate that using MY reduces the variance of the resulting stratum-level estimates. Further work continues at Texas A & M University (TAMU).

# TECHNOLOGY ASSESSMENT

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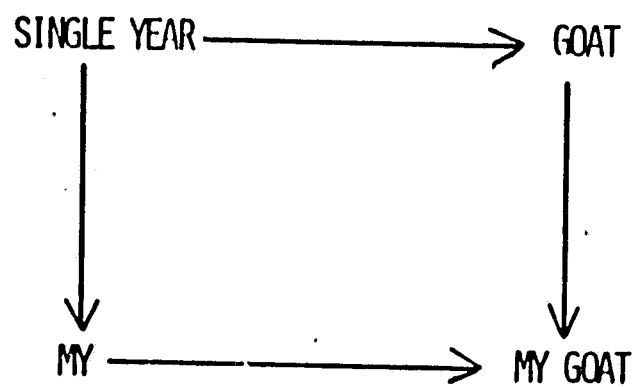


Figure A-25.- Progression of aggregation techniques.

# TECHNOLOGY ASSESSMENT

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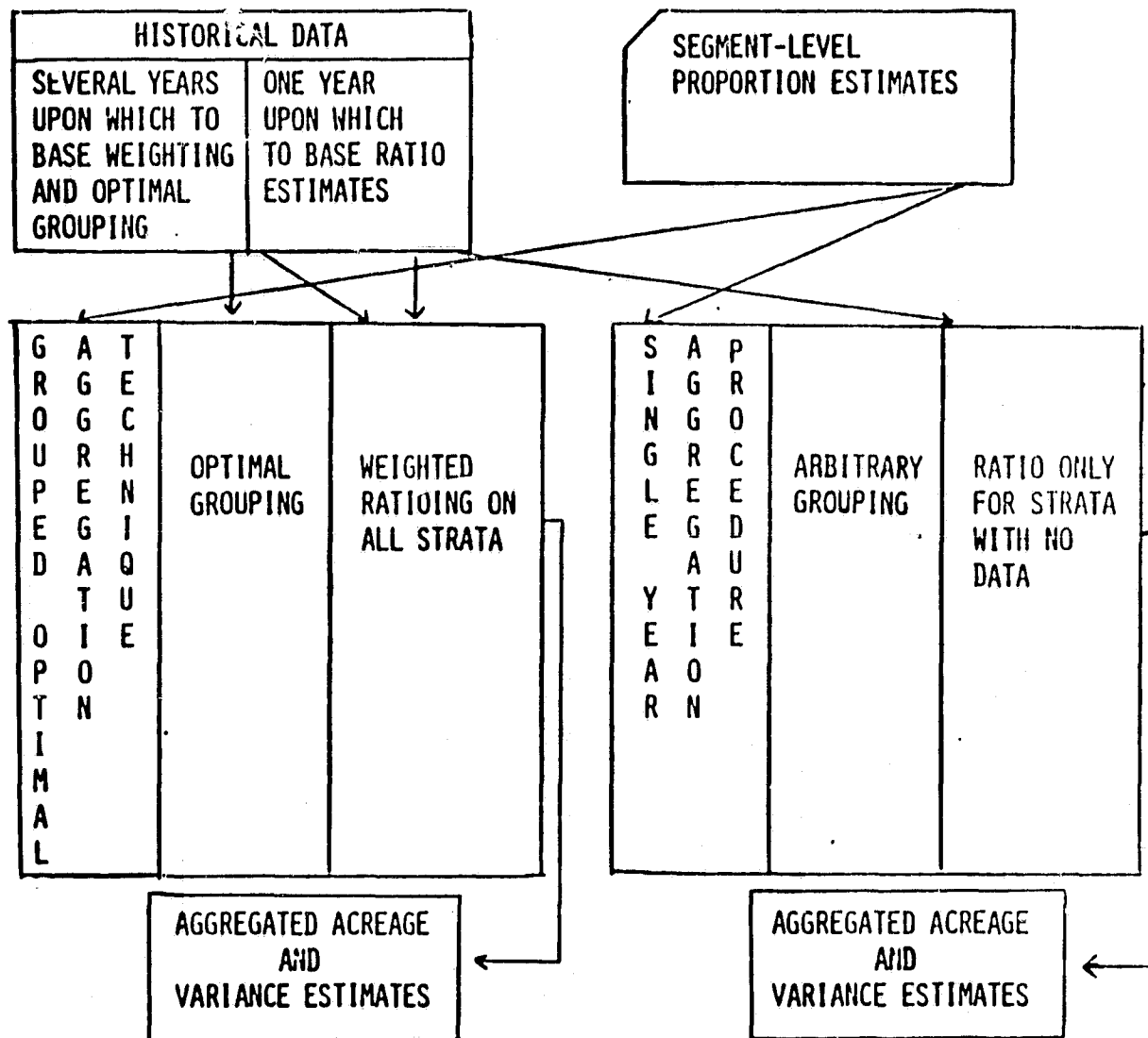
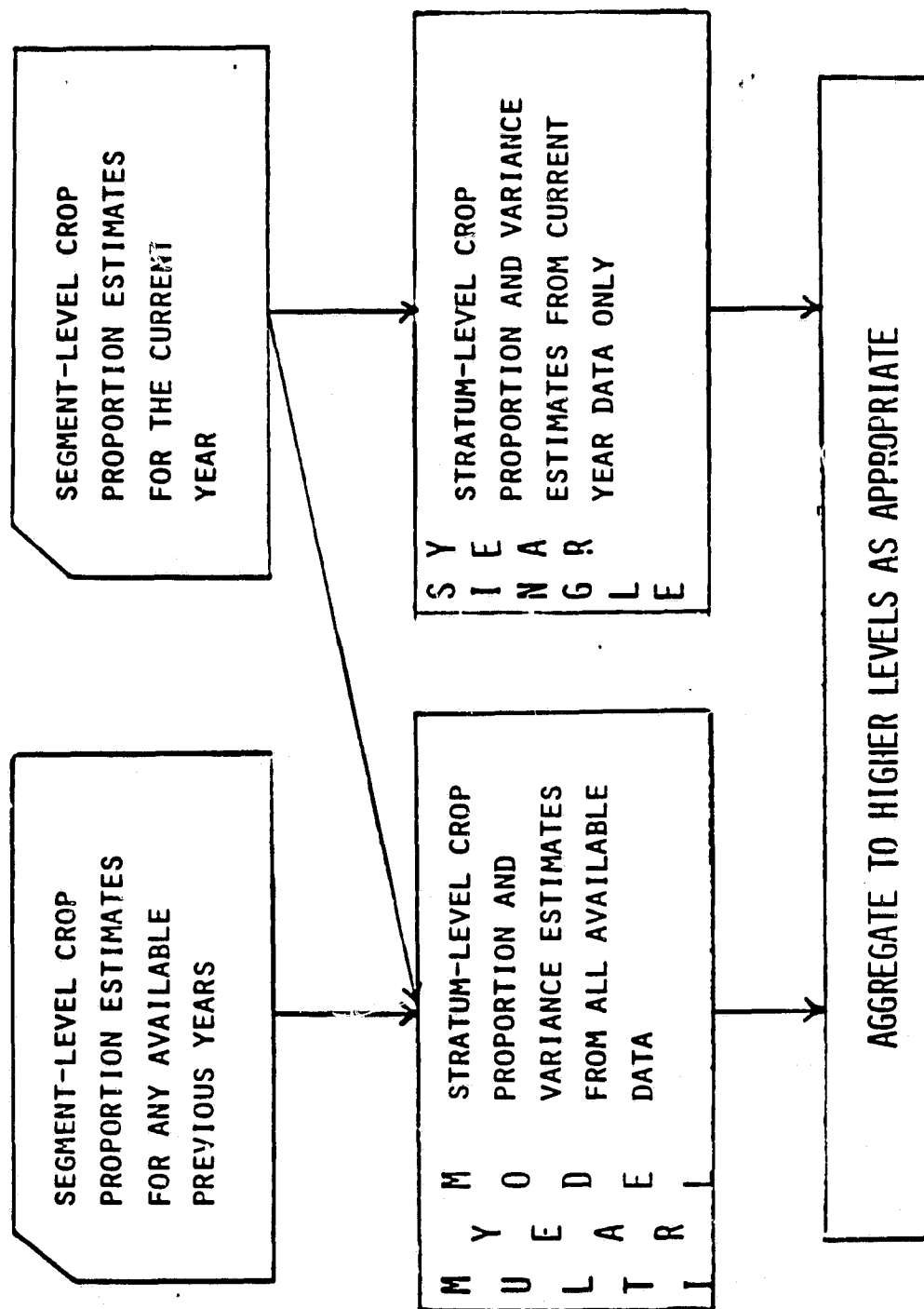


Figure A-26.- GOAT versus single year aggregation.

# TECHNOLOGY ASSESSMENT



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Figure A-27.- The multiyear (MY) model versus single year.

## A.2.12 HISTORICAL U.S.S.R. ESTIMATION

Table A-14 presents the LACIE, Phase III, U.S.S.R. estimation accuracy for total wheat production. Table A-15 presents the production, area, and yields estimates for U.S.S.R. winter wheat for Transition Year (1978) early season.

TABLE A-14.- LACIE, PHASE III (1977), U.S.S.R. ESTIMATION  
ACCURACY OF TOTAL WHEAT PRODUCTION

Month	RD, %	CV, %	Tolerance limits, %	Significance level, %
August	-3.3	4.3	(-4.5, 4.0)	50
September	0.3	3.9	(-5.6, 4.6)	50
October	-0.4	3.8	(-5.6, 4.6)	50
Final	-0.7	3.8	(-5.6, 4.6)	50

Symbol definition:

CV = coefficient of variance

RD = relative difference

TABLE A-15.- TRANSITION YEAR (1978) EARLY-SEASON PRODUCTION, AREA,  
AND YIELD ESTIMATES FOR U.S.S.R. WINTER WHEAT

Item	LACIE, Phase III (March 30, 1977)				TY (March 15, 1978)			
	Estimate	CV, %	U.S.S.R. estimate	RD, %	Estimate	CV, %	U.S.S.R. estimate	RD, %
Area (ha x 10 <sup>6</sup> )	21.3	6.3	20.7	-2.9	20.7	4.3	23.1	-11.0 <sup>b</sup>
Yield (ql/ha)	24.3	4.4	25.0	-2.9	22.8	2.9	(a)	(a)
Production (MT x 10 <sup>6</sup> )	51.6	7.0	51.9	- .6	47.1	4.0	(a)	(a)

<sup>a</sup>Date not available.

<sup>b</sup>Difference is insignificant.

Symbol definition:

CV = coefficient of variance

MT = metric ton

RD = relative difference

## ● The multiyear (MY) model

- Basic model:  $Y(PTS) = \alpha_T + B_S + E_{TS}$

Where

$Y(P_{TS})$  = A variate transformation of the segments estimated at-harvest crop acreage proportion for a given year,  $P_{TS}$ .

$\alpha_T$  = The stratum's transformed at-harvest crop acreage proportion for a given year.

$B_S$  = The departure from the stratum's transformed at-harvest crop acreage proportion for the sampled segment.

$E_{TS}$  = The total of: sampling errors, classification errors, model lack-of-fit, etc.

$T$  = The year in which the estimate,  $P_{TS}$ , was made.

$S$  = The segment for which the estimate,  $P_{TS}$ , was made.

The estimate of the stratum's at-harvest crop acreage proportion is:

$Y^{-1}(\alpha_T)$

A.2.13 OTHER TECHNOLOGIES

A.2.13.1 Additional Technologies for Potential Inclusion  
(No plans exists for inclusion at present.)

- Badhwar
- Chittinenni
- Environmental Research Institute of Michigan (ERIM)
- Distribution labeling
- Partial response

A.2.13.2 Other Technologies - ERIM Deliveries

- SSG Procedure
  - Not adapted to a U.S.S.R. environment
  - BLOB parameters set to optimize corn/soybean labeling; this results in a greater number of mixed BLOBS. (BLOB is an algorithm.)
  - Documentation not available until February 15, 1981
- Barley Procedure
  - Uses information about BLOB means
  - Is dependent upon preprocessing
  - Has no consensus at ERIM regarding non-ERIM spring small grains procedure interfaced with ERIM barley.
  - Unavailable documentation until February 15, 1981
- General
  - No software for proportion estimation

## TECHNOLOGY ASSESSMENT

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### A.2.13.3 Early Season Estimation Procedure

- Reasons for testing and evaluating of an early-season procedure during the U.S.S.R. Barley Exploratory Experiment follows:
  - No early-season procedure is currently available
  - Development of early-season procedures is underway in supporting research, but delivery dates do not support the U.S.S.R. Exploratory Experiment (i.e., Subjective Procedure - Delivery date July 1, 1981; Objective Procedure - Delivery date May 1, 1982).
- Alternative Solutions
  - Do a Shakedown Test prior to the pilot on the subjective procedure.
  - The objective procedure could undergo preliminary testing during the pilot.
  - Postpone early-season procedure use until it can be tested in an exploratory experiment (i.e., incorporate subjective and objective early-season procedures in an 1983 exploratory experiment).
- Impact
  - New analysts will need to be trained because those in the exploratory experiment will have already seen the at-harvest data.
  - Involves replanning and scoping of a future exploratory experiment.
  - A demonstration of early-season procedures in the U.S.S.R. would be jeopardized.
- Recommendations
  - Postpone early-season testing until the U.S.S.R. pilot experiment.
    - A demonstration of the subjective system would be possible pending a recommendation from the Shakedown Test.
    - An exploratory-type test could be run on the objective procedure if it is delivered as an automated procedure.

## DATA ASSESSMENT

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### A.3 DATA ASSESSMENT

#### A.3.1 LANDSAT DATA

- Approximately 355 segment-years are available for processing in U.S.S.R. IR's.
- Approximately 183 segment-years are available for processing in U.S. FSR's.
- Approximately one-fourth to one-half of the available segments are potentially processible for an at-harvest SSG estimate.
- FY 1976-79 U.S. Great Plains (USGP) Allocation Scheme
  - FY 1976 Large Area Crop Inventory Experiment (LACIE), Phase II, Neyman allocation to counties based on variability of total wheat acreage.
  - FY 1977 LACIE, Phase III, Neyman allocation to counties based on variability of total wheat production.
  - FY 1978 LACIE TY Neyman allocation to refined strata based on variability of total wheat production.
  - FY 1979 maintained ground truth segments from 1978 in North Dakota, Minnesota, South Dakota (6 segments), and Montana (2 segments).

#### A.3.2 U.S.S.R. HISTORICAL DATA

- Problems with U.S.S.R. historical data
  - Some oblast definitions change from year to year.
  - Missing oblast data
  - Bad historical data
  - Need to check problems in data for the past 4 years.
- Limited multiyear data

The historical data are obtained from the following sources.

- CIA data
  - Generally reported at the oblast level
  - Contains area, yield, and production information

## DATA ASSESSMENT

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- Some data are obviously estimated and discrepancies can be identified.
- No data are available which coincide with available Landsat coverage in the U.S.S.R.
- New computerized data set
  - Oblast-level reporting
  - Harvested area information
  - 1958-1978 crop years
  - All major crops
  - Currently being evaluated for completeness and reliability
- Official U.S.S.R. agricultural statistics
  - Economic region reporting
  - Planted area
- Reference documents
  - Documentation of agricultural statistics for various special areas and for reporting levels (i.e., national, republic, economic, regions)
  - Documentation on nonstatistical agricultural information such as winterkill, management practices, diseases, insects, and other.
  - Some documentation covering geophysical data such as soils, topography, and land use.

Tables A-16 through A-21 provide the following data: blind sites for U.S.S.R. FSR's, intensive test sites and blind sites within the U.S./Canada FSR's, segments available in U.S.S.R. IR's, barley ground-truth sites in the FSR's, and the FSR data set.

# DATA ASSESSMENT

TABLE A-16.- BLIND SITES FOR U.S.S.R. FSR's (1976-1979)

Year	Montana, APU 104	Montana, APU 23	North Dakota, APU 20	Minnesota, APU 20	Saskatchewan, Canada	Total
LACIE, Phase II, 1976	29	25	6	4	0	24
LACIE, Phase III, 1977	21	21	7	8	0	37
TY, 1978	5	5	7	3	15	35
Transition Project 1979	2	1	6	3	28	40
Total	27	22	26	18	43	136

<sup>a</sup>All segments are blind sites with at least one acquisition.

# DATA ASSESSMENT

TABLE A-17.- INTENSIVE TEST SITES WITHIN THE U.S./CANADA FSR'S

Year	Montana, APU 104	North Dakota/ Minnesota, APU 20	Manitoba/ Saskatchewan Canada	Montana, APU 23	Washington (Whitman County)	Idaho (Oneida, Bannock, Franklin Counties)	Total
LACIE, Phase I, 1975	0	1	2	4	3	3	13
LACIE, Phase II, 1976	0	1	6	3	3	3	16
LACIE, Phase III, 1977	0	1	6	3	2	3	15
Transition Year, 1978	0	0	0	1	0	0	1
Transition Project, 1979	0	0	0	0	0	0	0
Total	0	3	14	11	8	9	45

# DATA ASSESSMENT

TABLE A-18.- BLIND SITES WITHIN THE U.S./CANADA FSR'S

Year	Montana, APU 104	North Dakota/ Minnesota, APU 20	Manitoba/ Saskatchewan, Canada	Montana, APU 23	Washington (Whitman County)	Idaho (Oneida, Bannock, Franklin Counties)	Total
LACIE, Phase I, 1975	2	1	0	0	0	0	3
LACIE, Phase II, 1976	5	7	0	6	0	0	18
LACIE, Phase III, 1977	12	11	0	1	0	0	34
Transition Year, 1978	5	7	28	4	0	0	44
Transition Project, 1979	1	8	29	1	0	0	39
Total	25	34	57	22	0	0	138

# DATA ASSESSMENT

TABLE A-19.- SEGMENTS AVAILABLE IN U.S.S.R. INDICATOR REGIONS (IR's)

Numbers in parentheses indicate segments potentially processable for an at-harvest spring grain estimate.

Year	Belorussia IR		Caucasus IR		Southern Urals IR
	Gomel Oblast, 8 segments	Mogilev Oblast, 7 segments	Rostov Oblast, 61 segments	Stavropol Oblast, 45 segments	
1975	0	0	b <sub>0</sub>	b <sub>0</sub>	2 (0)
1976	a <sub>2</sub> (0)	a <sub>1</sub> (0)	32	23	45 (11)
1977	7	7	60	45	105 (28)
1978	0	0	c <sub>0</sub>	c <sub>0</sub>	8 (7)
1979	0	0	d <sub>0</sub>	d <sub>0</sub>	17 (0)
Total	9	9	92	68	177 (46)

a No acquisition for June and July.

b No acquisitions before September 1975.

c No acquisitions are available after April 1, 1978.

d No acquisitions are available after May 1979.

# DATA ASSESSMENT

TABLE A-20.-- BARLEY GROUND-TRUTH SITES IN THE FSR'S

State	Symbol	Year				Total and percentage range
		1976	1977	1978	1979	
North Dakota	X		6 (7-22%)	7 (7-20%)	1 (5%)	14 (5-22%)
	Y		6	10	13	29
	Z					
South Dakota	X				1 (6%)	1 (6%)
	Y				4	4
	Z					
Montana	X		8 (5-25%)	2 (9-12%)		10 (5-25%)
	Y		13	6		19
	Z					
Minnesota	X		5 (7-21%)	1 (7%)		6 (7-21%)
	Y		5	2		7
	Z					
Total	X		19 (5-25%)	10 (7-20%)	2 (5-6%)	31 (5-25%)
	Y		24	18	17	61
	Z					

## Symbol definition:

X = Number of segments with more than 5-percent barley and good acquisition histories or at least five acquisitions.

Y = Range of barley percentages.

Z = Number of segments with barley and at least five acquisitions.

# DATA ASSESSMENT

TABLE A-21.- FSR DATA SET

Year	Montana, APU 104 (Barley)	Montana, APU 23 (Barley/ winter wheat)	North Dakota, APU 20 (Barley/ spring wheat)	Minnesota, APU 20 (Barley/ spring wheat)	Saskatchewan, Canada (Barley/ spring wheat)	Total
LACIE, Phase II, 1976	2	1	2	3	0	8
LACIE, Phase III, 1977	3	2	0	3	0	8
Transition year, 1978	3	2	1	1	6	13
Transition Project, 1979	1	0	2	2	6	11
Total	9	5	5	9	12	40

APPENDIX B  
LEVEL B DATA REQUIREMENTS

APPENDIX B  
LEVEL B DATA REQUIREMENTS

B.1 GENERAL

Data Set identification forms for the preliminary Level B requirements for the U.S.S.R. Barley Exploratory Experiment are presented along with correspondence dated December 18, 1980.

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ENGINEERING AND MANAGEMENT SERVICES COMPANY, INC.

December 18, 1980  
Ref: 644-1912

Mr. R. M. Bizzell  
National Aeronautics and Space Administration  
Lyndon B. Johnson Space Center  
Houston, Texas 77058

Dear Mr. Bizzell:

Subject: Preliminary Level B Requirements for the USSR Barley  
Exploratory Experiment

The attached forms are to be submitted to the Data Systems Branch as the designated method of stating requirements for the USSR Barley Exploratory Experiment. An explanation of some of the listed requirements and additional requirements not currently covered in the forms is also attached. Due dates are as requested on the forms.

Prioritization of specific deliveries and other actions should be coordinated with Christine Dailey, Lockheed, USSR Barley Exploratory Experiment Integrator, room 243, building 17, extension 4761.

Although these are the Level B requirements, minor modifications are anticipated and will be submitted immediately following the presentation of the "Strawman" experiment design.

Sincerely,

*C. L. Dailey*  
C. L. Dailey

APPROVED:

*J. G. Baron*  
J. G. Baron  
Experiment Integration Manager

CONCURRENCE:

*F. W. Solomon*  
F. W. Solomon, Scientific Supervisor  
Data Requirements and Support Section

cc: JSC/L. F. Childs J. L. Dragg  
H. Prior  
L. Wade  
G. McKain  
LOCKHEED/J. J. Vaccaro w/o atch  
B. L. Carroll *RC*  
D. Marquis  
M. Pore  
L. Flores *LF*  
File

DATE OF REQUEST 12/15/80  
Page 1 of 18

## STANDARD DATA SET SITE IDENTIFICATION FORM

Std. Data Set # 112  
Task Number(s) - 13-0 5  
Date Required-Data Base  
Packets

Data Year - 1979

Packets - April 1, 1981

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USC Form 376 (Rev Aug 65)

DATA SHEET

**WASA-JSC**

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Task Number(s) 13-05  
Date Required Data Base - Feb. 15, 1981  
Packets - April 1, 1981

STANDARD DATA SET SITE IDENTIFICATION FORM

Date Year 1978

Area Number	Sample Segment	State	County	Latitude	Longitude	Row/Path	CRD/APU	Size	Year
1.	1725	MT	Flathead					117 x 196 pixels	
2.	1389	MT	Powder R.					117 x 196 pixels	
3.	1553	MT	Carter					117 x 196 pixels	
4 FSR	1945	MT	Valley					117 x 196 pixels	
5 1st	1825	MT	Norman					117 x 196 pixels	
6 Priority	1518	MT	Roseau					117 x 196 pixels	
7.	1514	MT	Marshall					117 x 196 pixels	
8.	1473	ND	Cass					117 x 196 pixels	
9.	1584	ND	Pembina					117 x 196 pixels	
10.	1619	ND	Grand Forks					117 x 196 pixels	
11.	1974	ND	Ransom					117 x 196 pixels	
12.	3050	Canada	Saskatchewan					117 x 196 pixels	
13.	3083	Canada	Saskatchewan					117 x 196 pixels	
14.	3112	Canada	Saskatchewan					117 x 196 pixels	
15.	3132	Canada	Saskatchewan					117 x 196 pixels	
16.	3166	Canada	Saskatchewan					117 x 196 pixels	
17.	3169	Canada	Saskatchewan					117 x 196 pixels	
18.	3197	Canada	Saskatchewan					117 x 196 pixels	
19.	1731	MT	Chouteau					117 x 196 pixels	
20.	3064	Canada	Saskatchewan					117 x 196 pixels	
21 FSR	3080	Canada	Saskatchewan					117 x 196 pixels	
22 2nd	3093	Canada	Saskatchewan					117 x 196 pixels	
23 Priority	3163	Canada	Saskatchewan					117 x 196 pixels	
24.	3185	Canada	Saskatchewan					117 x 196 pixels	
25.	3201	Canada	Saskatchewan					117 x 196 pixels	

ISC Form 376 (Rev Aug 85)

DATA SHEET

NASA-JSC

Date of Request 12/15/80  
Page 3 of 18

**DATA YEAR 1977**

Task Number(s)	13-05
Date Required	Data Base - Feb. 15, 1981 Packets - April 1, 1981
13-05	

[illegible]

JSC Form 378 (Rev Aug 65)

# DATA SHEET

**HASA-JSC**

## STANDARD DATA SET SITE IDENTIFICATION FORM

Task Number(s)	Date Required	13-05 Data Base Packets
1	10/1/80	
2	10/1/80	
3	10/1/80	
4	10/1/80	
5	10/1/80	
6	10/1/80	
7	10/1/80	
8	10/1/80	
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97	10/1/80	
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99	10/1/80	
100	10/1/80	

	Data Base - Feb. 15, 1981	Data Year 1976
Packets	- April 1, 1981	

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SC Form 370 (Rev Aug 65)

DATA SHEET

**WASA-VSM**

Requester/Org. **Dailey**  
Date of Request **12/15/80**  
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## STANDARD DATA SET SITE IDENTIFICATION FORM

Std. Data Set #	Task Number(s)	Date Required	R2	13-05	Data B

13-03	Data Base Feb. 15, 1981	Data Year 1978
1	1	1
2	2	2
3	3	3
4	4	4
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6	6	6
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9	9	9
10	10	10
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100	100	100

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DATA SHEET

**NASA-JSC**

Std. Data Set #  
Task Number(s)  
Date Required

KC  
13-05

STANDARD DATA SET SITE IDENTIFICATION FORM

Data Base - Feb. 15, 1981  
Packets - April 1, 1981

Date of Request: 12/15/80  
Page 6 of 18

Data Year 1977

Area Number	Sample Segment	Oblast	County	Latitude	Longitude	Row/Path	CRD/APU	Size	Year
1. USSR IR 7500		Bryansk						117 x 196 pixels	
2. USSR IR 7543		Moscow						117 x 196 pixels	
3. USSR IR 8040		Orel						117 x 196 pixels	
4. USSR IR 8050		Orel						117 x 196 pixels	
5. USSR IR 7565		Smolensk						117 x 196 pixels	
6. USSR IR 7544		Tula						117 x 196 pixels	
7. USSR IR 7513		Vladimir						117 x 196 pixels	
8. USSR IR 7045		Gomel						117 x 196 pixels	
9. USSR IR 7533		Kaluga						117 x 196 pixels	
10. USSR IR 7962		Orenberg						117 x 196 pixels	
11. USSR IR 7966		Orenberg						117 x 196 pixels	
12. USSR IR 7971		Orenberg						117 x 196 pixels	
13. USSR IR 8816		Orenberg						117 x 196 pixels	
14. USSR IR 7985		Orenberg						117 x 196 pixels	
15. USSR IR 7990		Orenberg						117 x 196 pixels	
16. USSR IR 7995		Orenberg						117 x 196 pixels	
17. USSR IR 8762		Orenberg						117 x 196 pixels	
18. USSR IR 8830		Orenberg						117 x 196 pixels	
19. USSR IR 9437		Orenberg						117 x 196 pixels	
20. USSR IR 8773		Orenberg						117 x 196 pixels	
21. USSR IR 7374		Rostov						117 x 196 pixels	
22. USSR IR 7377		Rostov						117 x 196 pixels	
23. USSR IR 7389		Rostov						117 x 196 pixels	
24. USSR IR 7858		Rostov						117 x 196 pixels	
25. USSR IR 7865		Rostov						117 x 196 pixels	
26. USSR IR 7880		Rostov						117 x 196 pixels	
27. USSR IR 7882		Rostov						117 x 196 pixels	

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DATA SUPPLY

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REQUEST NO. 12-15-80  
 Date of Request 12/15/80  
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STANDARD DATA SET SITE IDENTIFICATION FORM

Std.	Data Set #	K2	K3
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
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Data Year 1977 - cont.

13-03  
Data Base-Feb. 15, 1981

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DATA SHEET

**CSR-VSM**



NAME: Chris Dailey  
PHONE # 4761

[illegible]

## DATA SHEET



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Std. Val. del.  
Task Number(s)  
Date Required

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Data Base-Feb. 15, 1981  
Packets April 1, 1981

### Raw Data

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DATA SHEET

**25f-VSVN**

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CO-01  
Data Base - Feb. 15, 1981

**Packets - April 1, 1981**

**B-17**

# YIELD MODEL REQUIREMENTS REQUEST FORM

Std. Data Set # K2  
Date Required April 1, 1981  
Requester Dailey  
Date of Request 12/15/80  
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1. Location(s)	2. Crop(s)	3. Level(s) of Estimate	4. Years	5. Periodic Interval	6. Estimates	7. Data Format	8. New or Existing
N. Dakota Minnesota Montana	Barley	State CDR APU (N. Dakota Montana)	1978 1979	Monthly from plant- ing to harvest	yield, yield error variance, weather- related variance	Hard- copy	Montana is new

Saskatchewan

Same

Province

Same

Same

Same

Same

New:

## INSTRUCTIONS:

- Complete a row for each location or set of locations (e.g., State) for which there are some different requirements.
- Crop(s) for which estimates are required.
- Geographical level(s) of detail required (e.g., state, CRD, APU)
- Crop year(s).
- Estimation interval (e.g., monthly from planting to harvest).
- Yield estimates and variance components required (e.g., yield, yield variance, weather-related variance, yield error variance).
- Data format (e.g., hard copy, magnetic tape, direct terminal access, computer or storage location).
- Has this product previously been produced? (Existing)  
Is this requirement a new product? (New)  
(If you do not know whether the product is in the inventory or new, enter "unknown".)

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This page addresses (new, existing,  
unknown) products. (Circle one)

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Std. Data Set # R2  
Task Number(s) 13-95  
Date Required April 1, 1981  
Requester/Org. Dailey/Lockheed  
Date of Request 12/15/80

REFERENCE MAP/MOSAIC REQUIREMENTS FORM

COUNTRY/REGION/STATE: U.S./Montana,N.Dakota, Minnesota,Washington, Idaho Canada/Saskatchewan & Manitoba USSR/Belorussia Central Region N.Caucasus, Urals		Small Scale	1:5,000,000	1:1,000,000	1:500,000	Other	Date Needed	COMMENTS
<b>POLITICAL MAPS</b>	National	5					ASAP	For a general reference in analyst area
	State/Region	5					ASAP	For a general reference in analyst area.
	County,Oblast, etc.	5					ASAP	For a general reference in analyst area.
	Other political Subdivision							
<b>TOPOGRAPHIC</b>								
<b>THEMATIC MAPS</b>	Sample Segment	1					ASAP	For general reference for each year 1976-79.
	Satellite track with scene centers	1					ASAP	Overlay on sample
	APU	1					ASAP	Segment Map 12 & 13 For general reference in analyst area.
	CRD	1					ASAP	For general reference in analyst area.
	Ag/Non Ag.	1					ASAP	For general reference in analyst area.
	Aero. Charts							
	Agriculture							
	Climatology							
	Geology							
	Land Use							
<b>MOSAICS</b>	Meteorology Stats							
	Met Stations	1					ASAP	For general reference in analysts' area.
	Soil							
	Other USSR					10		
	Agricultural Atlas					Copies ASAP		For general reference in analysts' area.
<b>MOSAICS</b>	National							
	Reg./State							
	Strip							
	Other							

Insert number of copies required in appropriate boxes.

COMMENTS:

Std. Data Set # R2  
Task Number(s) 13-05  
Date Required April 1, 1981  
Requestor/Brq. Dailey  
Date of Request 12/15/80  
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## OPERATIONAL MEDIUM AND LARGE SCALE MAP REQUIREMENTS FOR J4

COUNTRY/REGION/STATE

Area Number	TOPOGRAPHIC MAPS			Date Needed	COMMENTS
	1:250,000	Large Scale	Other		
FSR 1-20 1979	1/packet	1/packet			These maps should be available in each packet for the area covered by the segment location. Largest scale available should be used.
FSR 1-25 1978	1/packet	1/packet			
FSR 1-8 1977	1/packet	1/packet			
FSR 1-11 1976	1/packet	1/packet			
IR 1-2 1978	1/packet	1/packet			
IR 1-27 1977	1/packet	1/packet			
IR-cont'd 1-5 1977	1/packet	1/packet			
IR 1-7 1976	1/packet	1/packet			

**Insert number of copies required in appropriate boxes.**

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B.2 CLARIFICATION OF INFORMATION ON LEVEL B REQUIREMENTS FORMS AND  
ADDITIONAL REQUIREMENTS

B.2.1 ANALYST PACKET PREPARATION

- All designated Level B segments need to be inventoried.
- The following products should be available in the packets when they are delivered.
  1. Image Products 1 and 3 for each image on the data base should be mounted and screened as described in U.S. Wheat/Barley Pilot Experiment requirements letter (Ref: 644-1875).
  2. Crop calendar and weather information including historical crop calendar, adjusted crop calendars for wheat and barley, and the climagraph products for that segment.
  3. Topgraphic maps

At least one map should be in the packet at the largest scale available (e.g., for U.S. segment 1:24,000 scale; for USSR 1:250,000 scale).
  4. Ancillary data
    - LACIE ancillary data which contain cropping practices and crop statistics.
    - Universal Strata Descriptor.
  5. Spectral aids which are necessary for use during initial segment analysis (TBD).
- If the production film convertor (PFC) is working, new image products should be generated and substituted for current imagery.

The priority for generation of image products would be:

1. Missing images Product 1
2. All Product 3
3. All remaining Product 1's.

Note: Any segments used during the U.S. Spring Grains Pilot Experiment should have met this requirement. (All FSR segments are a subset of segments requested for the U.S. Spring Grains Pilot Experiment.)

- All other materials currently in the packets should be removed and stored as described in Section 2.2, LACIE Transition Project Detailed Analysis Procedures, LACIE-00724, JSC-13756, May 1979. These materials should be stored in an area accessible to the analysts.

#### B.2.2 MATERIALS TO BE AVAILABLE IN THE ANALYST WORK AREA

- LACIE Weekly Meteorological Statistics for the U.S. and the U.S.S.R. for 1976, 1977, and 1978.
- Full-frame imagery.
- Maps designated on the Reference Map/Mosaic Requirements Forms.

#### B.2.3 DATA BASE PREPARATION

- Soil line computation should be run on all U.S.S.R. IR segments and any U.S. segments not prepared for the U.S. Small Grains Pilot Experiment.
- A merged and transformed data base should be set up for all the segments in this test as described in correspondence (Ref: 644-1910, October 3, 1980).
- Image screening information obtained from the "Image Screening Form" of all segments used in the exploratory are to be placed on a file accessible to the Acquisition Selection Program.
- Crop calendar information should be on a file, accessible and compatible with the Acquisition Selection Program.
- A directory file as described in correspondence (Ref: 644-1910) should be available for the segments specified on the Level B forms.
- Generate data from CLASSY clustering prior to the beginning of segment analysis; due date - April 1, 1981.

All of the preceding requests need to be implemented and their existence verified on the JSC system by February 15, 1981 (except CLASSY runs which are due April 1, 1981).

Note: The Laboratory for Applications of Remote Sensing (LARS) system should be used as a back-up until the new system becomes available.

#### B.2.4 DATA HANDLING

- The procedure which is currently outlined on the Sensor Data Form No. 2 includes the current procedures to be used in the U.S. Pilot and Exploratory Experiment and TBD candidate technology.
- All candidate technology which has been requested but remain TBD will be identified as soon as possible, and the final group of technology to be worked will be identified following the presentation of a preliminary experiment design.

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**APPENDIX C**

**1981 U.S.S.R. FSR SEGMENT ALLOCATION**

## APPENDIX C

### 1981 U.S.S.R. FSR SEGMENT ALLOCATION

Data sheets for the 1981 U.S.S.R. FSR segment allocations are included in this appendix.

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### DATA SHEET

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MONITOR (MI) 1 OF 2

TOTAL: 47

COMMUNITY	SEGMENT NO.	LAT.	LONG	USER	Aircraft Coverage Window	IMAGERY AVAILABLE	GROUND OBSERVATIONS	Applicable FSR
Big Horn	9547	45°12'00"	107°05'00"	FCPE	6/1-7/1		INVENTORY ONLY	USSR
Blaine	1929	48°49'57"	108°19'39"	FCPE	6/1-7/1	JSC (77)	18 DAY	
Broadwater	9548	46°17'00"	111°32'00"	FCPE	6/1-7/1		INVENTORY ONLY	
Cascade	1742	47°23'32"	110°59'37"	FCPE	6/1-7/1	JSC (78)	18 DAY	
Chautau	1731	47°57'42"	111°06'10"	FCPE	6/1-7/1	JSC (78)	18 DAY	
Custer	1103	46°21'00"	105°04'38"	FCPE	6/1-7/1	JSC (77)	18 DAY	
Carbon	9549	45°12'00"	108°39'00"	FCPE	6/1-7/1		INVENTORY ONLY	
Fergus	1948	47°36'40"	100°20'26"	FCPE/FSR	5/15-8/1	JSC (80)	18 DAY	
Flathead	1725	48°19'46"	114°11'45"	FCPE/FSR	5/15-8/1	JSC (78)	9 DAY	
Gallatin	1750	45°35'48"	111°06'48"	FCPE	6/1-7/1	JSC (77)	18 DAY	
Garfield	1536	47°08'30"	106°25'48"	FCPE	6/1-7/1		INVENTORY ONLY	
Glacier	1964	47°09'00"	112°32'55"	FCPE	6/1-7/1		INVENTORY ONLY	
Golden Valley	9550	46°07'00"	109°30'00"	FCPE	6/1-7/1		INVENTORY ONLY	
Hill	1734	48°20'05"	110°41'43"	FCPE	6/1-7/1	JSC (77)	18 DAY	
Judith Basin	1747	46°53'59"	109°59'22"	FCPE	6/1-7/1	AMES	18 DAY	
Liberty	9551	48°38'00"	111°11'00"	FCPE	6/1-7/1		INVENTORY ONLY	
McCone	9552	47°15'00"	105°50'00"	FCPE	6/1-7/1		INVENTORY ONLY	
Pondera	1937	48°09'26"	111°50'45"	FCPE	6/1-7/1	JSC (77)	18 DAY	✓
Powder River	1389	45°40'28"	105°26'16"	FCPE	6/1-7/1	JSC (77)	18 DAY	USSR
Richland	1548	47°45'48"	104°16'00"	EW	6/1-7/1	JSC (80)	9 DAY	
Sheridan-2	9556	48°24'46"	104°28'48"	EW	6/1-7/1		9 DAY	
Stillwater	9554	46°03'00"	108°56'00"	FCPE	6/1-7/1		INVENTORY ONLY	USSR
Teton	1938	47°48'14"	112°04'23"	FCPE	6/1-7/1	JSC (78)	18 DAY	
Toole	9555	48°42'00"	111°29'00"	FCPE	6/1-7/1		INVENTORY ONLY	
Prairie	9553	47°10'00"	106°00'00"	FCPE	6/1-7/1		INVENTORY ONLY	USSR

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**DATA SHEET**

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TOTAL: 38

SEGMENT NO.	LAT.	LONG.	USER	AIRCRAFT COVERAGE WINDOW	Priority	IMAGERY AVAILABLE	GROUND OBSERVATIONS	Applicable FSR
1472	46° 42' 35"	98° 07' 24"	FCPF	6/1 - 7/5	1	JSC (80)	18 DAY	USSR
1392	47° 56' 40"	99° 13' 55"	P2	5/15 - 8/1	1	JSC (80)	INVENTORY	
1609	48° 06' 08"	99° 33' 50"	P2	5/15 - 8/1	1		INVENTORY	
9563	47° 56' 00"	98° 52' 00"	P2	5/15 - 8/1	1		INVENTORY	
9564	47° 51' 00"	99° 42' 00"	P2	5/15 - 8/1	1		INVENTORY	
1460	48° 30' 10"	101° 20' 04"	P2	5/15 - 8/1	1		INVENTORY	
1610	48° 57' 04"	100° 56' 04"	P2	5/15 - 8/1	1		INVENTORY	
1611	48° 51' 34"	101° 22' 36"	FCPF/P2	5/15 - 8/1	1	JSC (80)	18 DAY	USSR
9565	48° 46' 00"	100° 23' 00"	P2	5/15 - 8/1	1		INVENTORY	
919	47° 02' 00"	100° 21' 25"	EW	6/1 - 7/5	1		9 DAY	
817/818	46° 57' 00"	97° 03' 00"	FCPF/SR	6/15 - 8/1	1	JSC (80)	9 DAY	USSR
1617	48° 55' 27"	98° 48' 50"	FCPF/SR	5/15 - 8/1	1	JSC (78)	18 DAY	USSR
1658	46° 04' 42"	98° 18' 43"	SR	5/15 - 8/1	1	JSC (79)	9 DAY	
1619	48° 05' 06"	97° 29' 37"	SR	6/1 - 7/5	1	JSC (80)	9 DAY	
1918	46° 18' 18"	101° 18' 00"	SR	5/15 - 8/1	1	JSC (79)	9 DAY	
1909	47° 04' 30"	99° 42' 29"	SR	5/15 - 8/1	1	JSC (80)	18 DAY	
1391	48° 11' 49"	100° 52' 22"	SR	5/15 - 8/1	1		INVENTORY	
1612	48° 03' 02"	100° 17' 22"	P2	5/15 - 8/1	1	JSC (79)	INVENTORY	
1897	48° 29' 20"	100° 54' 17"	P2	5/15 - 8/1	1		INVENTORY	
9566	47° 56' 00"	100° 35' 00"	P2	5/15 - 8/1	1		INVENTORY	
9567	48° 31' 00"	100° 24' 00"	P2	5/15 - 8/1	1		INVENTORY	
9568	48° 36' 00"	100° 42' 00"	P2	5/15 - 8/1	1		INVENTORY	
1465	47° 58' 40"	98° 31' 46"	EW	5/15 - 8/1	1	JSC (79)	9 DAY	
1584	48° 48' 02"	97° 15' 26"	FCPF	5/15 - 8/1	1	AMES	18 DAY	USSR
1461	48° 13' 00"	99° 59' 28"	SR/P2	5/15 - 8/1	1	JSC (79)	9 DAY	

DATA SHEET

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DATA SHEET

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